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JACKSON'S SHIPS' LINES.

By EDWARD JACKSON, of Manila, Philippine Islands.

MY plans and model in the Centennial Exhibition, now with the New York Yacht Club, having gained a medal and first-class diploma, I ask leave to make the lines known in America through your valued paper.

It is well known that in America the shallow form of vessel, that of *horizontal displacement*, has found much favor, while in England there still exists a deep-rooted prejudice for the narrow deep form, that of *vertical displacement*. In truth, each variety has its advantages; my object has been to combine them, and I believe, as far as sea-going vessels are concerned, I have even succeeded in enhancing them.

The small cargo vessels up to 100 tons register yet built on the lines have shown, for their size and propelling power, unequalled speed, ease of motion, steering qualities, and security. For full explanation of the principles on which the lines are based, I refer to a paper I had the honor to read before the Institution of Naval Architects in London, in April, 1875, copied into *Engineering* of the same month, with the discussion that followed, in which one of the society's most distinguished members, Mr. John Scott Russell, accorded to one of my drawings the highest praise.

Fig. 1. Juanita. Design for a yacht to the length of the celebrated American yacht Sappho. The Juanita shows much greater initial stability or power of maintaining uprightness under sail pressure, and notwithstanding her rather higher center of gravity and smaller total weight, she should have quite a tenth more stability at a heel of 20°. Her lines are considerably finer, as shown by the compared cylindroids, or spindle or cigar form, to which the immersed areas have been reduced. For whereas both yachts are almost exactly of the same size forward of the mid length, the Sappho has to drag 800 cubic feet more after-body through the water. Hence, as the Juanita would carry more the existing system, and her great length of entry shortens her run. In my lines, on the contrary, after-beam does not necessitate a coarse run, the entry and run cross each other, each being longer than half the vessel's length; a fine entry is got by straight-water lines, and a fine run by the easiest of buttock lines. The stern is peculiar, but the drawing shows how much more smoothly it will plunge into the sea than one of the usual form; it improves the load line, decreases after-lift, its helm port or rudder hole is as well under water as in and out of it, and if it is not prettier it ought to be. Both stem and stern are much more American than modern English, and, theorists notwithstanding, the ends should lengthen the lines and not blunt them when the vessel pitches or ascends.

Fig. 1

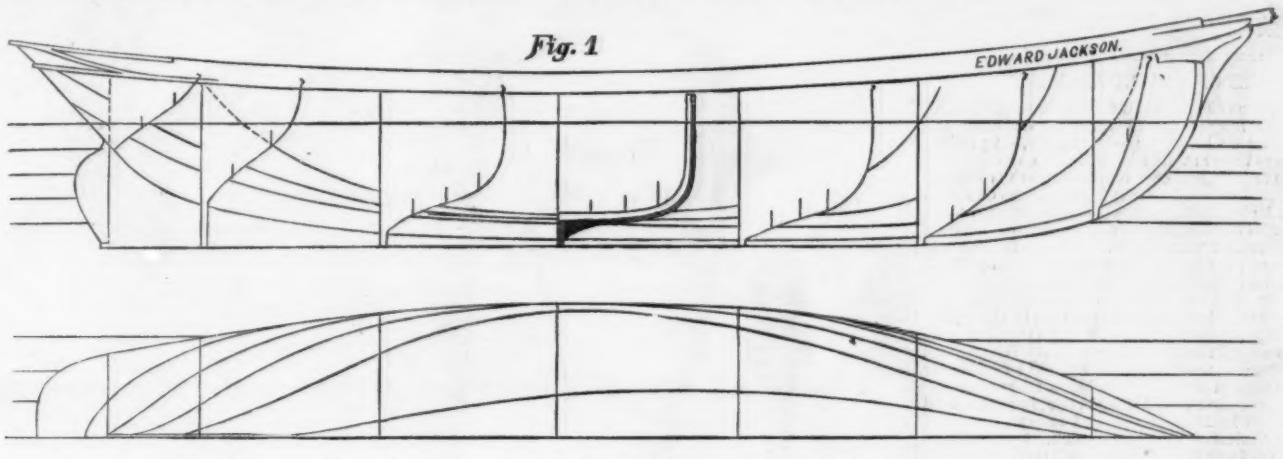


Fig. 2

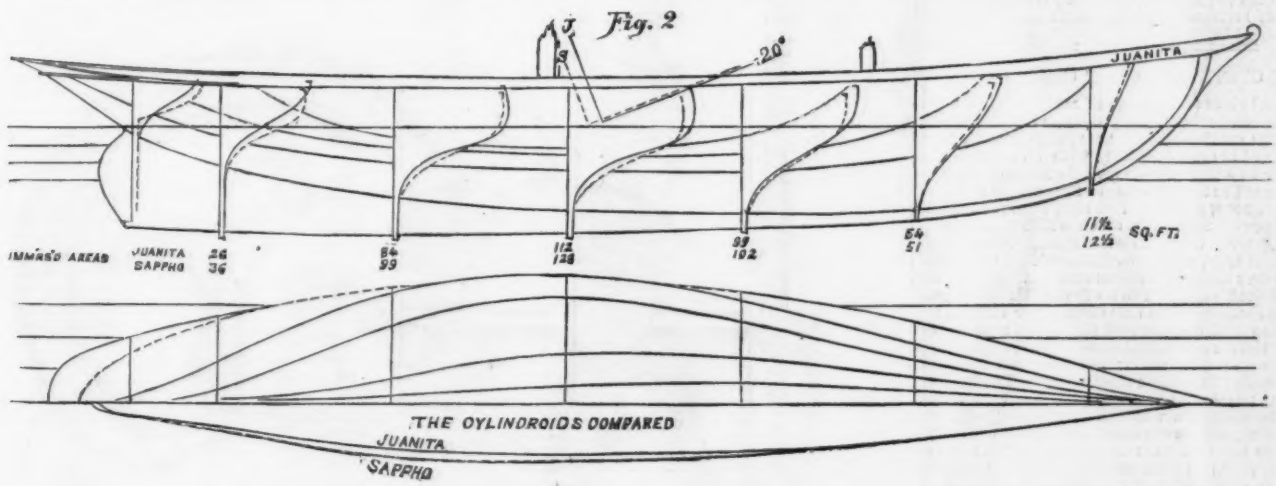
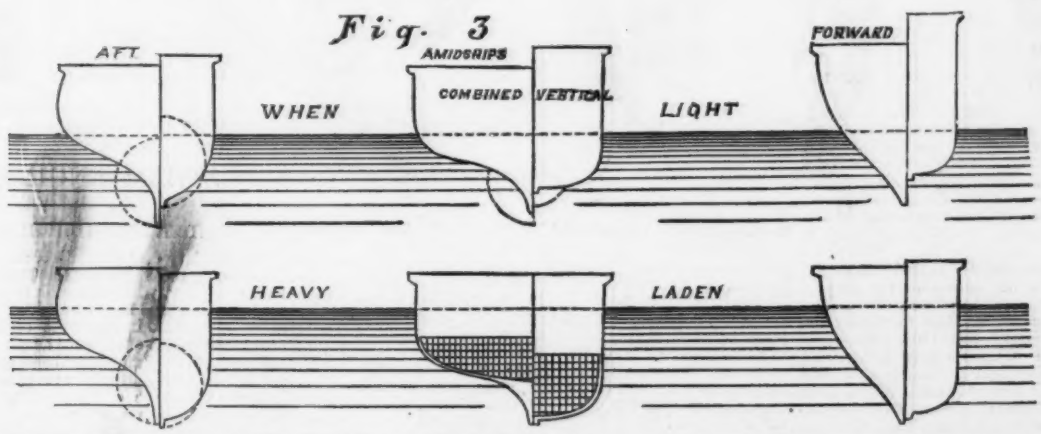


Fig. 3



DESIGN FOR YACHTS AND OTHER VESSELS. BY EDWARD JACKSON.

As an example of large displacement, combined with lines to give speed on or off the wind, in smooth water or rough, I give another drawing, Fig. 3, that of a vessel of 350 tons register, to carry fully 500 tons of dead weight and a very large measurement cargo. In America the great beam does not call for excuse, but it will be noticed that even when deeply loaded the draught of the high *flat* floor would be but one third of the beam, and, as has been so well pointed out by Mr. Griffiths, it is not great beam that causes heavy rolling, *but low bulk and low weight*. My lines, too, give the sail or get more effect out of the same sail, as her resistance is smaller, as she has equal lateral resistance as compared with her longitudinal resistance, as she would incline less, and as when inclined she would have much less after-lift, and better steering qualities with smaller draught of water, she must, as far as figures and numbers can prove, be a faster vessel in any wind or sea, and she certainly would be a safer, easier, and drier one.

For though the Sappho, judging from her lines, must be *very* hard to beat, she cannot escape the inherent difficulty of

additional safeguard of their great fineness below and great lateral hold on the water, with the cleanest of runs of solid undisturbed water to rudder or screw. Neither need there be any fear that the sharp bow will cause pitching; it is not only buoyant in itself from its distance from the longitudinal centre of gravity, but it cannot dip without excessive rise of displacement aft. This vessel would need no ballast, and in her the difficulty of stowage would be reduced to the trim of her load line; she could carry copper on her floor or timber on her deck; she would be easy with heavy cargoes and stable with light ones.

For the still further elucidation of my system, I also add comparative cross sections of vessels on the combined lines and of the extreme vertical displacement common in steamships in England, but, to the honor of America shipowners, avoided in the States. The cross sections show the contrast in the position of heavy cargo on the floor, and also the contrast in the same vessels when light, when the combined form takes lines like a yacht's, retaining stability, after draught and vertical entry; whereas the vertical form becomes deficient in stability and screw draught, and its forward sections become so shallow that it has the disadvantage of horizontal displacement against a head sea.

A NEW CHANNEL STEAMER.—A new twin steamer for the Channel Steamship Company, built upon the same principle as the Castalia, but differing in important points of construction, and intended to secure speed as well as prevent sickness, was launched from Leslie's yard on the Tyne recently. This vessel is named the Express, and is composed of two complete hulls, 300 feet long, from the inner sides of which rises an arch, bearing an immense superstructure, containing cabins and saloons, and occupying nearly the entire width of the hull, and almost the whole length of the bow. The vessel steams either way, as there are complete and independent engines in each hull. The total power is 5,000-horse.

DRAINAGE OF THE ZUYDER ZEE.

ACTIVE preparations are going on for the immediate commencement of the long-projected work of draining the Zuyder Zee. A dam 40 kilometers—24 miles 1,504 yards—long, and 50 meters broad at its base, is to be carried across the gulf, built up to a height of ½ meter above the ordinary level of high tide. Upon this, pumping machines of 10,000 horse power will be erected, capable of pumping up from the inclosed sea and discharging on the outside of the dam 6,500,000 cubic meters of water daily. Taking the average depth of the water at 4½ meters, it is estimated that the work of pumping will be completed in about sixteen years from its commencement. The total cost of reclamation is set down at 335,000,000 fr., but, huge as this sum is, the undertaking is confidently looked upon as likely to prove a most remunerative speculation. The success of the scheme will add to the kingdom a new province 195,300 hectares—or nearly 500,000 acres—in extent. Judging from previous experiences in connection with Haarlem Sea, it is reckoned that at least 176,000 hectares of the land thus won will be applicable to agricultural purposes, which, at an average value of 4,000 fr. only per hectare, will richly repay the enterprise and treasure lavished on the gigantic undertaking.—*Farmer*

MILITARY OBSTRUCTION OF CHANNELS.

A DUTCH journal gives an account of recent experiments at Helvoetsluis on submarine barriers of rope for the closure of channels. A 20 centimeter rope was placed transversely to the channel, fixed at each extremity with an anchor, and in the middle by 10 other anchors, while ropes of 8 centimeters were arranged in the direction of the channel. These were held up by buoys, and, two and two, were made fast, extending a distance of 200 meters on each side of the principal rope. They were about 7 meters apart. Lastly, parallel to the principal rope, and on each side of it, was another rope of 8 centimetres fixed by anchors and fastened in crossing the longitudinal cords. Trial of the barricade was made with a monitor having an iron shield over each of its two screws. The vessel was directed full steam against the barrier. One of the screws fouled some of the longitudinal ropes. Whenever the ship struck the principal rope the screws were stopped. The thick rope was found to be broken, and two of the longitudinal ropes were torn away. "Except this, the barricade was little damaged." On examining the monitor, ropes were found entangled with both screws. The iron bands of the shields had cut the ropes at the barricade, but they had diminished by about 3 knots the speed of the ship, and hindered the liberation of the rope from the screws.

THE SOAP MINE.

A CORRESPONDENT of the Ventura *Free Press* gives the following concerning the operations of the Rock Soap Company, whose mine is in that county: "The company commenced the year under embarrassing circumstances, having contracted previously to ship the rock to a second party in San Francisco, who was to manufacture and sell the article independent of the company. Under their contract the amount of crude rock to be supplied was limited to one ton per month. The company took the manufacture of the article into its own hands some time in June, and used in first three months over four tons of the rock. The shipments for the last three months amount to 14 tons—an actual increase in the shipments of nearly four tons per month. The sales the past 10 months aggregate nearly 40 tons. The company have not only advanced by their enterprise the commercial interests of our county, but they have made improvements at the mine and in the facilities for getting out the rock. They have constructed a good wagon road two and one-half miles over a rough mountain region from the coast, at considerable expense, so that now the rock is hauled direct from the mine to the wharf. They formerly packed it down to the stage road on donkeys.

Notwithstanding the prospects of a dry year, the company are confident the manufacture and sale of their soap will continue to increase even more rapidly than last year. Agencies have been established in England, France, and Germany, and the shipping at San Francisco is accepting it as the finest salt-water soap in use.

The future of our country will be greatly brightened by the development of this one interest. The inexhaustible mountains of the material, and the hauling, the shipping, and the quarrying will afford employment and business for all time. This, with our oil wells, will most certainly aid in the rapid settlement and permanent development of the county and southern California.

ROBERTSON'S IMPROVED STEAM ENGINE.

WE present in the annexed engraving an engine invented by Mr. John Robertson, of the Tubal Cain Ironworks of Brooklyn, N. Y. The essential features of this engine are that the piston reciprocates in the arc of a circle, and it is distinguishable from the predecessors of its class in that the spring wheel, which has hitherto been the great drawback, is here entirely obviated. This is done as follows: Hitherto an ordinary piston fitting closely to the bore of the cylinder has been employed, and as a consequence the thrust and pull due to the steam pressure acting on the area of the piston had to be communicated to the crank through a piston bent to an arc of a circle corresponding to the arc of the bore of the cylinder. The result was found to be that the piston rod sprung under the enormous pressure, causing it to bend against the gland and stuffing or packing ring, which also acted as a fulcrum to force the piston itself against the bore of the cylinder. This not only induced excessive friction but tended to wear the cylinder and the piston oval; for, during the thrust, the piston would be forced against one side of the bore of the cylinder, while during the pull, on the return piston stroke, the piston would be brought to bear on the diametrically opposite side of the cylinder bore. In addition to this, the cylinder required to be bored true, which has proved a difficult task. The manner in which these difficulties are obviated in the Robertson engine are as follows: Referring to our engravings in Fig. 1, which is a sectional side view, *a a* is the cylinder; B B, the piston; *c*, a centerpiece, to which B B is bolted, and which has journal-bearing in boxes provided upon the cylinder or frame, to which one end of the connecting rod F is pivoted by means of an ordinary crank pin. G is the crank, and *m* the flywheel. H is an ordinary eccentric to operate the side valve, which is of the three-port type; *h* is a piece separating the two chambers *a a*, the exhaust port passing through it, and the steam ports being one on each side of it. E is a gland for packing the piston. Referring now to Fig. 2, it will be observed that in one casting we have the cylinder, the frame, and the flywheel bearings. The bearings upon which the piston vibrates are also cast solid upon the same casting. The pistons B are firmly bolted to the middle piece carrying the crank pin, the object being to facilitate the turning or pulling of the pistons. To secure beyond peradventure the pistons upon the middle piece, they are let or recessed into it.

The pistons, it will be observed, do not fit against the sides of the cylinder except over a small projecting piece at the top, which serves as an abutment for the packing, the space for which is shown between it and the end of the gland E. The space between the pistons and the cylinder bore is made to be as small as possible, and represents the clearance usually found in the long steam passages incidental to these ported valves. The pistons, B B, are solid castings, whose strength insures them against spring. The packing which keeps them steamtight represents the steam packing of an ordinary piston, the gland and packing being dispensed with. A feature of this plan is that any piston leak becomes apparent at once, and the nuts being on the outside the packing may be tightened and the leak stopped immediately without stopping the engine. Steam is admitted alternately through the ports on the right and left hand of the dividing piece N, giving to the piston a reciprocating semi-rotative movement, the steam acting on the ends of the pistons. The eccentric rod is hooked to the rocker arm I, the latter being provided with a handle whereby to operate the valve by hand when starting the engine. K is the valve stem, and L the steam chest. The whole arrangement of parts is compact and strong, there being no cams, links, or other light or slender pieces in the entire engine. At the same time every bolt and nut can be got at from the outside, and is under the eye of the engineer; while the use of guide-bars, guide-blocks, and crosshead, is dispensed with.

FIG. 1.

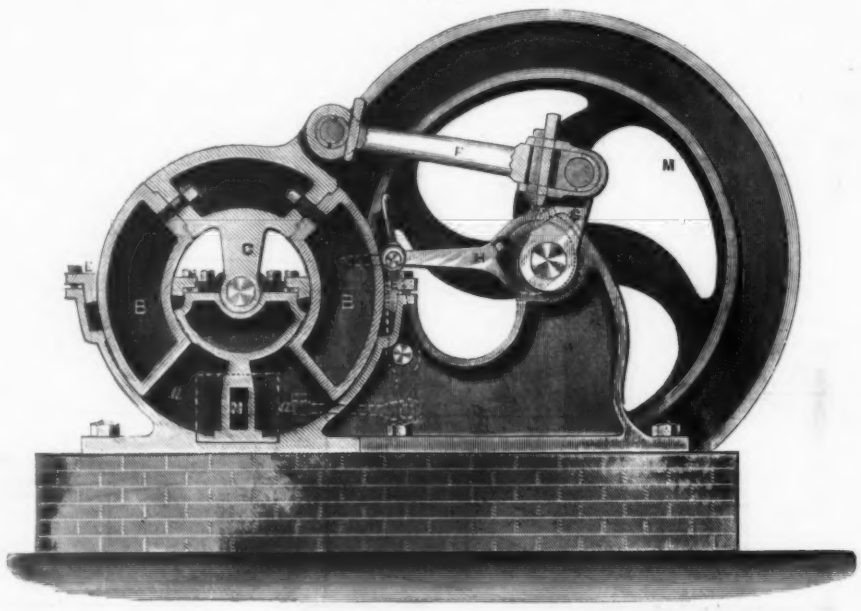
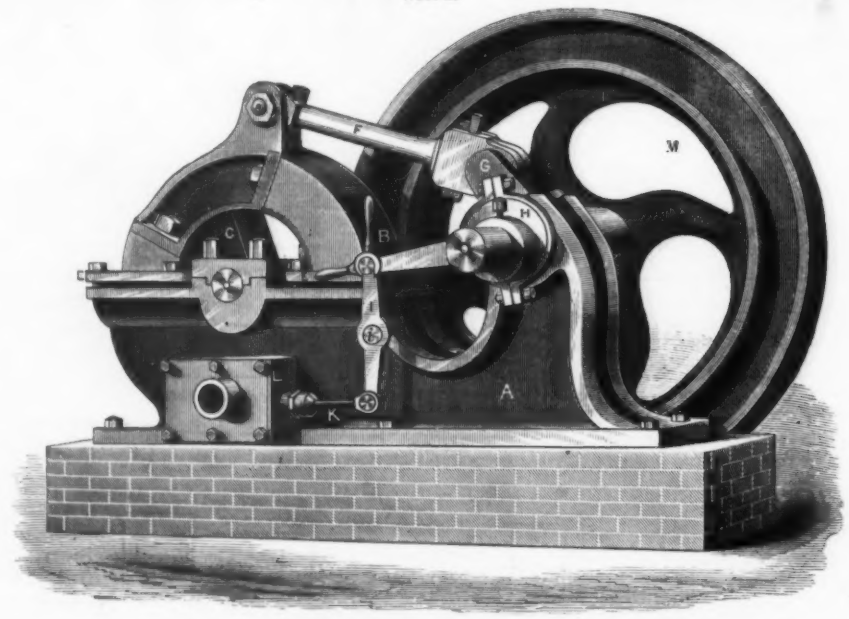


FIG. 2.



ROBERTSON'S IMPROVED STEAM ENGINE.

UNDERGROUND PUMPING ENGINE.*

THE tertiary coal field of Fohnsdorf, near Judenburg and Zeltweg, in the valley of the Mur, belongs to the Styrian Iron Company, who have sunk three shafts, about 500 yards apart, from which levels are driven at vertical intervals of about 57 yards to intersect the coal seam.† At present the coal is in process of removal at the first and second levels, and two of the shafts have been sunk to a third level, 180 yards below the surface, in preparation for deeper workings.

In the first stage of the workings a 30 horse power pumping engine in each shaft, working two lifts of 9½ in. pumps, the rods being moved by spur gearing and bell cranks, proved sufficient to keep the mines dry, but with increased depth the volume of water encountered became very much larger, so that further pumping power became necessary. This has been supplied by sinking a rectangular shaft of small size (5 feet in the slide, and 27 square feet available area) near the center of the field worked, at a point 72 ft. south, or on the dip side of the deepest drawing shaft, to a depth of 600 feet. The sump of this shaft, being connected by levels with the lower workings of the different mines, receives the whole of

* From James Forrest's "Abstracts of Papers in Foreign Transactions and Periodicals," for the Proceedings of the Institution of Civil Engineers.

† This according to another authority is from 9 to 15 feet thick.—H. B.

their drainage water, which is lifted to the surface by a pair of direct-acting pumping engines, placed near the bottom of the shaft. The chamber containing the engine, which is 52·9 feet long and 20·7 feet broad, is cut out of the rock, and was at first only partially secured by walling on the sides and roof, the ground consisting of strong shales and hard coal, being sufficiently firm; but when nearly completed, a fault in the strata was cut through, which disturbed the ground to such an extent that the floor began to thrust upward, so that it became necessary to line the entire excavation with masonry. The form of the work as finished is similar to that of a railway tunnel. The sections of the roof, side walls, and floor are semicircular, the respective radii being 10·3 ft., 20·7 ft., and 17·2 ft. The walling, which is 25·6 in. thick, except where the fault is crossed, where it is increased to 32·3 in., is carried out in common brickwork, set in cement, except the keystones of the roof and the floor arch, which are in specially moulded large firebricks. The engine bed is also in brickwork and cement, squared blocks of stone being used to take the pull of the holding-down bolts. Four transverse girders of wrought iron are built into the walls above the engines to facilitate the removal of any parts of the machinery for examination or repair.

The engines, which are designed to lift 695 gallons of water 623 ft. high per minute, with a working steam pressure of four atmospheres, and 149 ft. per minute piston speed, are of a horizontal direct-acting pattern, with variable expansion (Meyer's) gear and condensing. The flywheel, to which both engines are coupled, weighs 10¼ tons, is 18·4 ft. in diameter, and is placed behind the steam cylinders. The pumps, having each two working barrels, with a plunger common to both, are placed between the steam cylinders and the air pumps, which are also double acting. The steam cylinders are 33 in., the pump plungers 10·8 in., and the air pumps 12·4 in. in diameter, the length of stroke common to all these being 27·3 in. There are two valve boxes and air vessels to each working barrel of the pumps. The valves consist of metal balls, 21 in each box, 2·48 in. in diameter, and 0·315 in. lift, giving a clear water way of 1·7 in., so that at every stroke made by the pump 42 suction, and the same number of pressure, valves are put in action. The valve seats, also of metal, are arranged in a step form, and the boxes are placed to the right and left of the working barrels so as to get the largest amount of clear water way without making any part of undue size. The valve boxes in each pair are united below by a suction pipe 5·7 in. in diameter, and the four sets of pressure valves in each engine discharge into an overhead main of 8·85 in., which is connected by a similar one from the other engine, with the common rising pipe of 12·4 inches in the shaft.

The condenser valves, of which there are eight to each engine, are india rubber disks, 6·63 inches in diameter, and the air pump is so arranged that it may act as a suction lift to the main force pump, the latter being, however, provided with independent suction pipes in order to lift directly from the sump, if necessary; the height of the suction lift is about 16·4 feet.

The exhaust steam from the engines is admitted to the condenser by a mouthpiece containing three conical diaphragms, having a clear annular aperture of 7·28 in., within which the main suction pipe is placed concentrically. The water from the latter causes a rapid flow of steam through the conical tubes; and both currents, being brought into intimate contact by the diaphragms, rapid and complete condensation is effected. The condensers are so arranged, however, that the exhaust steam may be diverted and passed out by a waste pipe to the surface, when the engines are worked without condensation. The actual height to which the water is lifted is only 570 ft., but as it is intended to establish coal-dressing machines at the surface, which will require the point of discharge to be placed at a higher level in order to obtain the necessary head for the washing water, the engines have been constructed to work under 623 ft. head, corresponding to the pressure of 19 atmospheres, under which conditions the total pressure upon each plunger is about 10 tons, and that on the steam pistons, with an absolute steam pressure of 5 atmospheres, about 20 tons. The net power required, apart from all resistances, is about 130 horse power. The pump barrels, valve boxes, and air vessels, which are of cast iron, strengthened with rings and feathers, have been proved to a pressure of 40 atmospheres, and all surfaces of contact are united by turned shoulders fitting into corresponding sockets. The cranks, piston rods, cross heads, and similar moving parts, are of Bessemer steel. The total weight of the engines, exclusive of flywheel and connecting pipes, is about 55 tons.

The boilers, five in number, are placed above ground, and the steam is conveyed to the engines by a pipe 9·84 in. in diameter, coated with non-conducting material to prevent loss of pressure as much as possible. The loss of pressure between the boilers and the engine, which are 715 ft. apart, was 6½ lbs. upon an initial pressure of 60 lbs., or 10·8 per cent., with a naked steam pipe; but when a length of 398 ft. was covered this was reduced to 5 lbs., or 8·3 per cent.

The rising pipe in the shaft is of cast iron, 12·4 in. inside measure, the thickness being tapered, according to position, in four series, proportionately to the resistances, in the following order:

19	atmospheres.....	1·210 inch	= 30·8	millimeters
13½	"	0·990 "	= 25·2	"
9	"	0·798 "	= 20·3	"
4½	"	0·688 "	= 17·5	"

The separate lengths are united by turned flanges with double india rubber packing rings.

The engines were started at the end of July, 1876, and delivered at the normal working speed, 757 gallons of water per minute, or about 87 per cent. of the theoretical discharge of the pumps. The variations of pressure, as observed by a gauge placed at the bottom of the rising pipe, is between 18 and 19 atmospheres. Experiments have also been made by disconnecting one pump and running the other with both engines. Under the latter conditions, when the number of revolutions did not exceed 12 to 13 per minute, the variation of pressure was very slight; at 14 revolutions it was included between 19 and 22 atmospheres; and at 19 or 20 revolutions fluctuated between 8 and 30 atmospheres. The great difference in resistance under the latter condition is to be attributed to the circumstance that when the position of the crank is between 0° and 90° the water in the rising pipe is accelerated, and similarly between 90° and 180°, retarded in its movement. It would, therefore, be necessary to put on a special counterpoise in order to work the engines effectively under this condition. In spite, however, of the great variations in resistance observed in the latter experiment, the engines worked perfectly smooth, and the fluctuations of pressure noticed could only be detected by observing the gauge. When working 14 hours out of the 24, which is sufficient to draw the water for the present extent of workings, the consumption of small slack or dust coal is about 11 tons.

The total cost of the engines and necessary works, together with that of an engine of equal power above ground working pumps in shaft, is given as follows (the florin taken at 2s.):

1.	Sinking engine shaft and connecting level.	£2,223
2.	Cost of engine chamber.....	1,413
3.	Five boilers, boiler house, and stack.....	3,875
4.	The pumping machinery, complete.....	1,798
5.	Raising pipe in shaft	722
6.	Main steam pipe in shaft.....	398
7.	Exhaust steam pipe in shaft.....	113
8.	Suction pipe to pump.....	59
9.	Freight, cartage, and erection charges	683
	Total amount.....	£11,284

The following estimate of cost of engine at the surface is calculated for a 70 in. single cylinder direct acting engine, with a stroke of 106 in., placed above the mouth of the shaft, working two plunger lifts of 2·06 ft. in diameter at four strokes per minute, the excess weight of the main rod being counterpoised by a balance box:

1.	Cost of shaft and connecting levels, the former being of 68·9 square feet section.	£2,500
2.	Five boilers, as above	3,870
3.	Engine house and foundation for the steam cylinder (wrought iron girders above the mouth of shaft).....	1,550
4.	Wrought iron main rods and connections for pump lifts (about 70 tons)	1,540
5.	Cast iron rising pipe, 23 6 in. internal diameter, tapered in thickness as before...	1,280
6.	Steam pipe and connections.....	30
7.	Cost of engine	2,000
8.	Cost of two plunger-lifts	1,200
9.	Cost of counterpoise for rods.....	130
10.	Freight, carriage, and erection.....	1,020
	Total amount	£15,125

The underground engines have, therefore, been erected at a smaller cost of about £3,840. H. B.

MACHINE FOR SQUEEZING PUDDLERS' BALLS.

By EDMUND SUCKOW, Buffalo N. Y.

THE puddler's ball, as it comes from the furnace, is placed into the receiver H, from whence it will roll between the rollers, and there travel toward the rear end of the rollers, whereby it is compressed and squeezed, in a manner as hereinafter described, between the adjacent portions of the periphery of the three rollers A A' A'', in conjunction with the spiral projections thereon.

In this passage of said ball it is caused to revolve in a direction with the said rollers, and, in the commencement of the action of the same, in a direction at right angles thereto, which movement results in a compound rotary motion of said ball. This result is produced by the helical projections of one or more of said rollers differing in pitch from those of the remaining rollers, or by revolving the same faster, or by a combination of both varying pitch and accelerated speed. In this manner the ball is perfectly squeezed from all sides and afterward compressed and stretched, and it emerges from the delivery end of the machine through the opening I' in a perfect condition as a round muck bar.

It will be observed that the rollers are made tapering, and have their axial lines all parallel. This may be varied, making the rollers parallel and their axial lines converging, which would produce the same result of making the space between the adjacent portions of the rollers tapering, and would, therefore, be a mechanical equivalent of the arrangement heretofore described.

The revolution of the ball in a direction with that of the rollers is caused by frictional contact therewith, in combination with the notches *z* in the spirals, the former movement thereof by the spiral projections, and the revolution at right angles to the plane of the rollers by the varying pitch of said spirals. It is therefore evident that, for simply revolving the ball in a direction with the rollers, plain or longitudinally grooved rolls would answer this purpose perfectly well; but, to insure the compound forward movement and rotary motion, at least one of the rollers should be spirally grooved; and to produce the compound rotary and rectillinear motion, two rollers, at least, must be spirally grooved, and one of these must have spirals of greater pitch than the remaining one. For this reason it is obvious that, while all the rollers may be spirally grooved, it is not absolutely necessary that they should be so constructed, but that one may be a plain or longitudinally grooved, and the remaining two spirally grooved, and their pitch made to vary in any one of the manners hereinbefore described. It is furthermore obvious that the diameters of the rollers may be varying without interfering with their action.

In order to deeply indent the ball when first introduced, and in a nearly liquid state, and to knead the same thoroughly, and also to assist in the revolving of the ball, and to prevent it from separating on account of the shifting action of the spirals, these are made of V shape, with their forward or leading side very steep, or nearly at right angles to the plane of the rollers, and on the forward end very high, so as to imbed themselves sufficiently into the pliable mass of iron to insure its being properly worked. For this reason, also, one of the rollers is provided with scores or notches in the spirals, as shown in Fig. 2, into which the soft metal forces its way, forming, as it were, projections, which act, in conjunction with said scores or depressions, in a manner similar to that of cog-wheels, thereby aiding in revolving said ball; but since the ball while advancing becomes more solidified, and therefore capable of better withstanding such action, these scores or notches, as well as the spirals, are made shallower and closer together, so as not to feed the bloom too fast, and not to leave marks therein when it leaves the machine.

To compel parts of the ball detached during the squeezing and kneading process—should such take place notwithstanding the precautionary measures taken in the peculiar construction and shape of the spirals—to reunite, I have located the lower roller F in its indicated position, to prevent the detached parts from falling through, and thereby enabling them to attach themselves again to the bulk of iron, which, at that stage of the process, is still at a welding-heat, and also to assist in the revolution of the ball, while the sides between the middle and upper rolls are protected by shields K to prevent their escape through the space covered by these shields.

To enable the proper "criping" of the rollers on varying sized balls, I have made the upper one self-adjusting by means of the sliding boxes *a* in said frame. The forward end of this roller is allowed to rise and fall freely, and of its own accord, so as to adapt itself to the varying contour of the ball, a lever, N, and connecting-rods, P, being provided to lift that end for a free introduction of the ball. But the rear end of this roller should, preferably, be adjusted by means of the screw R, so as to produce muck bars of uniform diameter, the difference in size of the balls evidencing itself in their length.

To keep the rollers cool during operation, I make them hollow, and introduce a current of water through the trunnions or bearings thereof by means of the pipes S. To strengthen them, they are internally provided with radial ribs, as shown in Fig. 1.

FIG. 1.

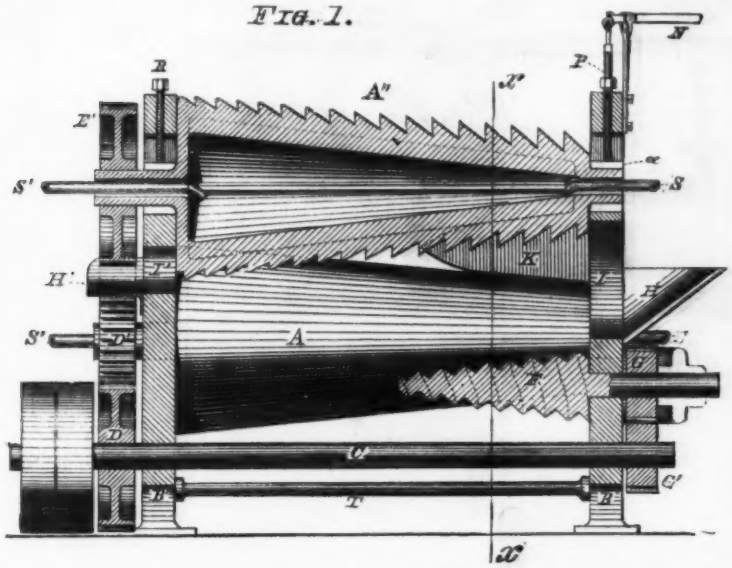


FIG. 2.

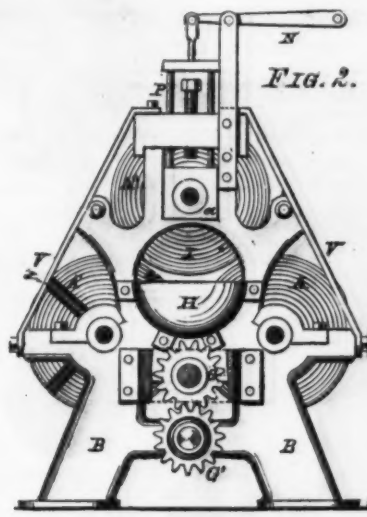
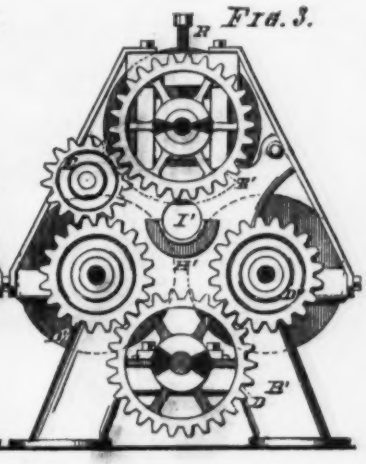
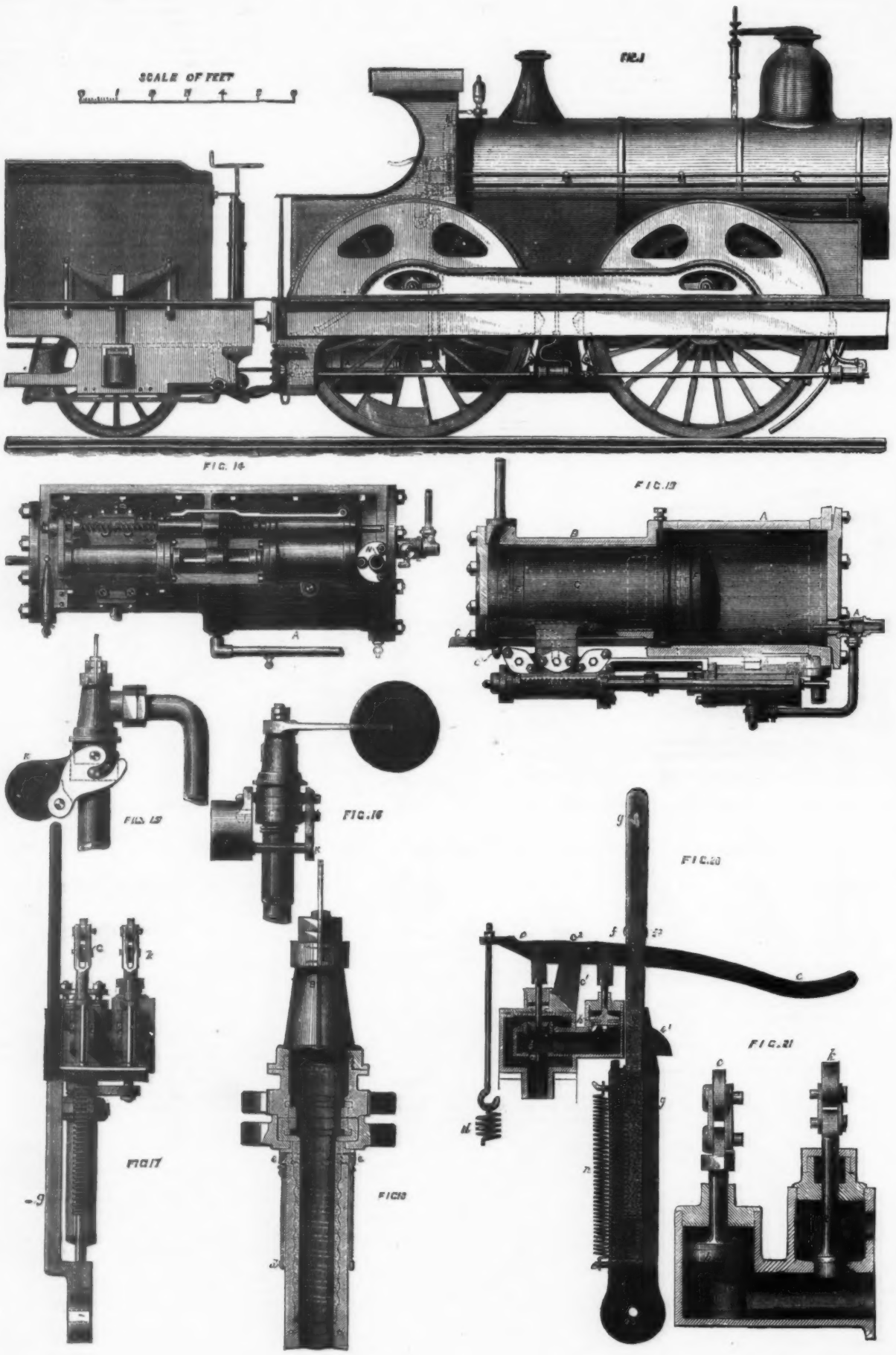


FIG. 3.



IMPROVED MACHINE FOR SQUEEZING PUDDLERS' BALLS.



BARKER'S IMPROVED HYDRAULIC BRAKE, MIDLAND RAILWAY, ENG.

BARKER'S HYDRAULIC BRAKE.

WE illustrate above the most recent and improved form of the well-known hydraulic brake, invented some six years since by Mr. Barker, of Bedford Row, London. The brake in its early form was worked by a set of pumps in the guard's van driven by a friction wheel. As now used on the Midland Railway, an ingenious steam pump, fitted under the foot plate of the engine, supplies a pressure which can be varied between 5 lbs. and 360 lbs. on the square inch. The pump starts of itself when the pressure falls below a certain point, and its duty consists in always keeping an accumulator filled, the load on the accumulator being supplied by the pressure in the boiler. The brake blocks are operated by small hydraulic presses, as shown in the engraving.

Fig. 1 is a part elevation of the locomotive, Fig. 2 shows the foot-plate fittings, Fig. 3 is part of the framing of a carriage, Fig. 4 a cross section, and Fig. 5 a plan of the same, all the parts in which will be readily understood without further description. The diameter of the brake cylinders is 4½ in.

One of the features of the new brake is an arrangement for preventing the blocks from receding too far from the wheels and so wasting water, which has to be pumped in again with a loss of time, which would interfere with the prompt action of the brake. This is shown in Fig. 9. Inside the press is a spring coiled round the plunger A. After the pressure is shut off, this forces the water that has applied the brakes through the main pipes to a tank on the engine. At one end the spring works against the piston B, at the other against the cover of the cylinder H H. This soring takes the blocks off. M, Fig. 8, is a slight rod with a slotted eye at M^1, working on a stud N. The length of this slot determines the amount of play of the blocks.

On the end of the rod, close to the brake blocks, teeth are cut, and this part of the rod passes through a slot in a bracket bolted to the hanger (see Fig. 10) which carries the brake block, and the bracket is furnished with a pawl O, which is pressed into the teeth of the rod by means of the india rubber spring *r* (Fig. 11).

Upon the clearance becoming too great, a tooth is automatically slipped upon the application of the brake and the proper distance again established. The top of the brake block is prevented from hanging on the wheel by means of a small spring, and it is furnished with a ratchet arrangement the reverse of the one just described, and it effects its object notwithstanding the varying angle of the hanger.

The leverage obtained by the carriage arrangement is very small, being as 4 : 3, but is much more than sufficient to compensate for the action of the spiral spring within the cylinder, and also for any loss of power by friction of parts. The main pipe is of an uniform diameter of 1¼ in.; this size is quite sufficient to insure the brake being prompt in its action.

The last point about the carriage arrangement is the coupling; the old union was effective and useful, but it had the disadvantage of being slowly put together, and required a certain degree of skill to prevent the screw threads from crossing in fastening and unfastening. The new arrangement is shown in Figs. 15, 16, and 18; this last is a section; A A are metal nozzles, inserted into flexible hose. On the nozzle beyond the end of the flexible tube a collar *e* is provided; it has a groove in it; wires run round this, and leaving it by notches pass lengthwise down the outside of the hose. Another wire is wound tightly round these, and makes a very secure fastening; the nozzles are supplied with vulcanized india rubber rings, which make a tight joint when butted together.

To hold together the upper nozzle, which is screwed on to the cock B, to the lower nozzle at G is joined a double-weighted lever K, with curved slots in it, which embrace studs on the lower nozzle, and so, by revolving the cam or claw, the parts are firmly clasped together. Owing to the heavy weight on the lever, the parts hold together until they are intentionally released.

We now pass to the engine arrangement, Figs. 14, 17, 19, 20, and 21. The accumulator A may be popularly described as a gigantic steam squirt with a tap in the pipe leading from it. The pump is so constructed as to force water into the accumulator and overpower the force of the steam in the accumulator. When the accumulator is full, the pump is stopped by a self-acting throttle valve. When it is desired to apply the brake, the driver pulls over the handle of the tap, and sufficient water passes through the pipes already full to fill the cylinders and apply the brake.

The pump is shown in Figs. 12, 13, 14, and 19. The steam cylinder B and pump cylinder A are, as is usual in direct acting steam pumps, in a line with one another, and a piston rod secured to the piston of each cylinder passes through stuffing-boxes in the two cylinder covers in the ordinary manner.

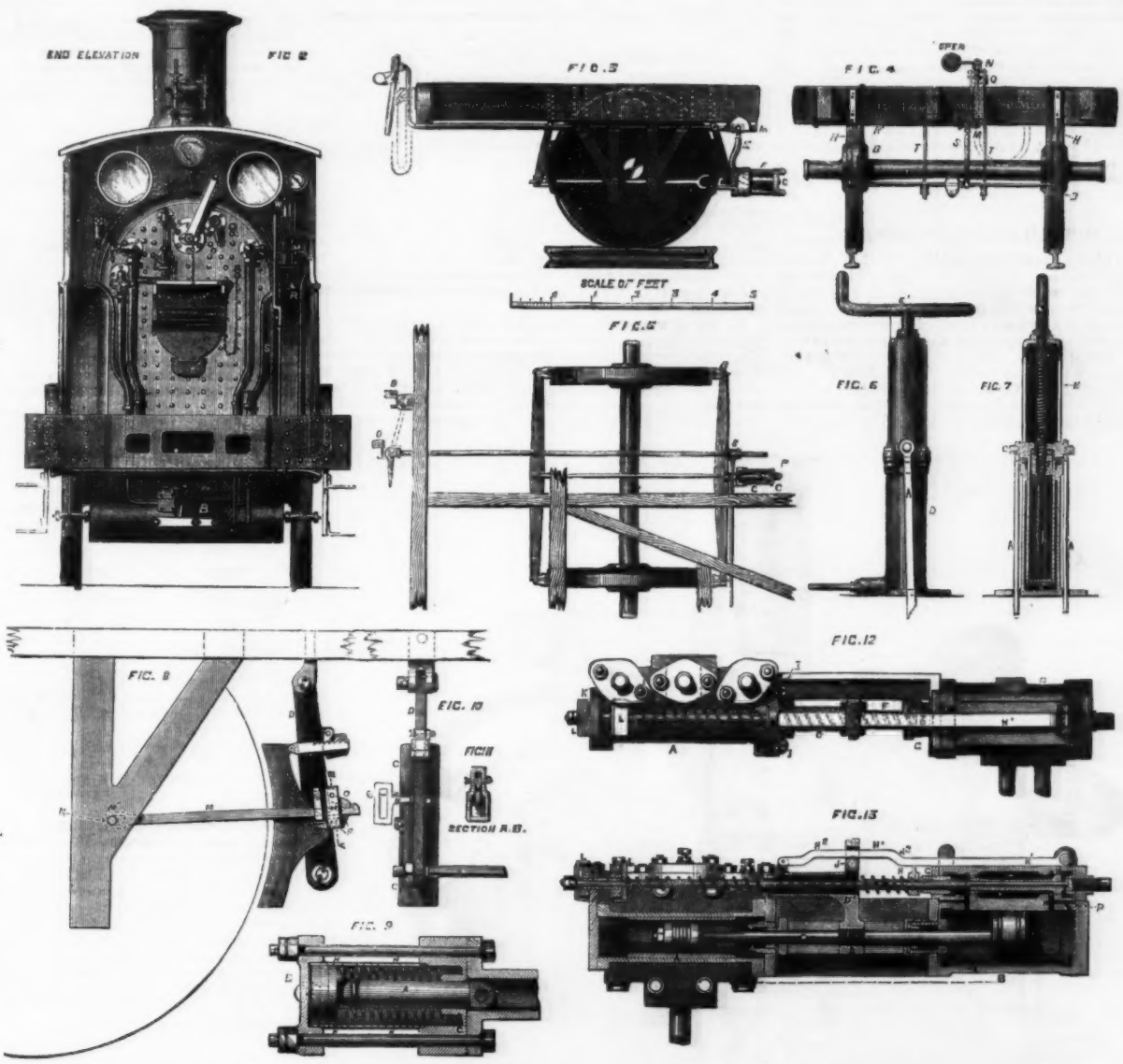
The admission and escape of steam from the steam cylinder are controlled by a piston valve M M. From the valve a rod passes out through the end of the valve chamber, and lies parallel with the piston rod of the steam and pump cylinders. Between the two cylinders the piston rod has a crosshead D attached to it, which embraces the valve rod and is free to slide to and fro upon it. Upon the valve rod are two coiled springs F F, one on either side of the crosshead D^1, and abutting at their opposite ends against collars on the valve rod. By this means, when the piston of the steam cylinder passes beyond the center of its stroke, one or other of the coiled springs is compressed, and tends to shift over the valve from one position to another. The valve, however, is prevented from moving over by a projection upon the valve rod C coming against a stop H, carried by a lever H^1, this lever is free to turn upon a pin at one end, and is held down by springs at its other end. As the piston of the steam cylinder completes its stroke, a roller J upon the crosshead of the piston acts upon an incline H^2 on the lever above mentioned, and lifts the free end of the lever; the stop upon the lever is thereby moved out of the way of the projection upon the valve rod, and the valve is instantaneously thrown over by the action of the coiled spring which has been previously compressed, and the valve is held over in its new position by the same spring which has just thrown it over. As the piston of the steam cylinder travels back, the stop lever is drawn down by its springs, and retains the valve from moving over until the completion of the stroke, when it is again set free, and shifted in a manner previously described.

The ports N N, for admitting steam to and exhausting it from the two ends of the steam cylinder, enter the cylinder at some distance from its ends. From each port is a branch of contracted dimensions P P leading to the recessed end of the cylinder. The piston of the steam cylinder at the ends of its strokes passes beyond, and so closes, the main port N, whilst the contracted branch port P remains open, whereby the piston is brought to rest quietly, and started back again in a similarly quiet manner.

The accumulator, Figs. 14 and 19, is bolted under the foot-plate of the locomotive; it consists of two cylinders placed end to end. Each cylinder is fitted with a piston, E F; the axes of both cylinders are in the same right line, and the pistons are on the same rod, *a*, as the larger cylinder A. Steam is admitted by the pipe N, Fig. 14, coming from the steam dome; the smaller cylinder B holds the water, and is the accumulator proper. The area of the larger piston is twice that of the smaller; therefore, whatever the boiler pressure is, the water in the small cylinder will be under twice the pressure. There is a volute spring inserted into the head of the piston, giving a pressure of three tons in addition to the steam pressure. The area of the water piston is 78·54 in. when the boiler pressure is at 140 lbs.; the water pressure per square inch equals 360 lbs. In the pump, which we have just described, the area of the steam piston is three times that of the water piston, consequently the pump is able to fill the accumulator against the steam pressure in it; when the accumulator is filled the piston F, Fig. 19, comes against the spindle of the throttle valve A^1, and forces it to its seat; steam is thus automatically cut off from the pump, and it remains idle until the accumulator makes a stroke, when the pressure of steam against the throttle valve, aided by a spring, forces the valve off its seat, and the steam passes through the pipe M, Fig. 19, to the pump, and starts it. A ratchet rod C passes into the accumulator at A^2, and works in the annular space between the pistons, and is fastened to the larger piston, and moves with it, and is so arranged as to turn a cog-wheel C^1, on an endless screw; this again works a water piston, and a small pipe passes up to a gauge-glass, W, on the fire-box of the locomotive.

The duties of the driver as regards the brake are first to fill the 30-gallon tank which is placed in the tender tank, and then to turn on the water to the pump; the water gravitates through the valves, and fills the accumulator, and steam is turned on to the accumulator at the cock fixed against the fire-box; afterwards the steam is turned on to the pump. Supposing the carriage pipes have also to be filled with water, this is done by coupling up and blowing the water from the accumulator through them.

Nothing remains but to describe the regulator. By its means the pressure can be adjusted with the greatest ease from 5 lbs. to 300 lbs. per square inch. The regulator is fixed near the fire-box. In the regulator valve, upon the



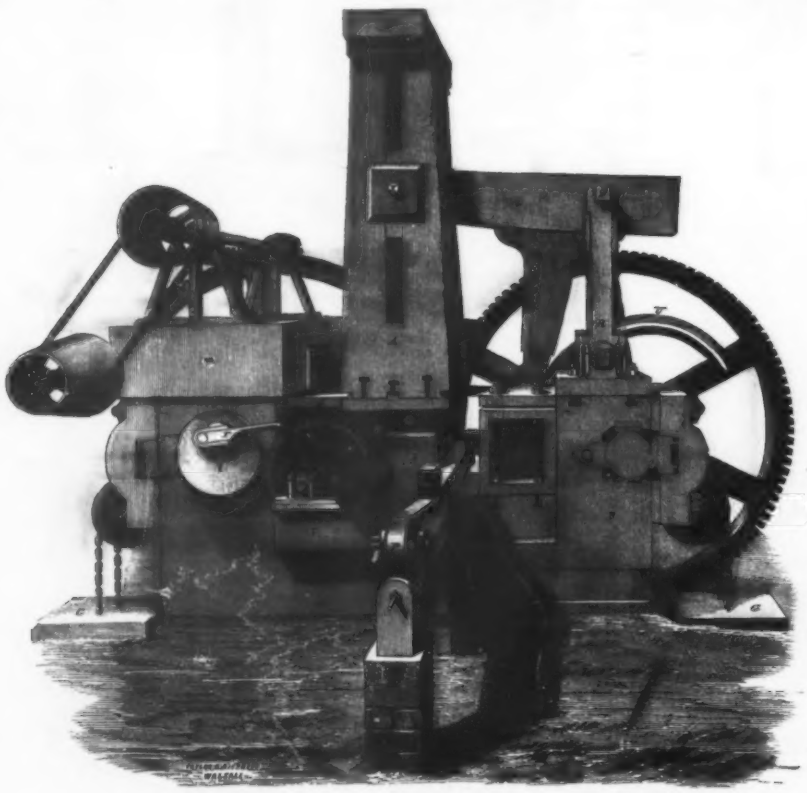
BARKER'S HYDRAULIC BRAKE, MIDLAND RAILWAY, ENG.

spindle, is a water piston *b*, Figs. 17, 20, and 21, having the same area as the valve *a*; water, under the pressure of the accumulator, is on both sides of the valve chamber, consequently the valve is easily kept in its seat by means of the slight spring *d*, on the lever *c*, to which the spindle of the valve *a* is attached. Connected also to the lever is a small piston *h*, which works in a cylinder packed with a cup leather. A bracket c^1, cast on the valve case cover, carries at a point midway between the valve *a* and the piston *h*, the fulcrum c^2, of the lever; it is so arranged that any pressure on the piston *h*, which lifts the lever, tends to shut the valve *a*. On the lever *c* runs a pulley f^2, in a rod M, forked at its upper end to embrace the lever *c*, and at its lower end works up and down in a hole in the oscillating bracket *g*. On this rod *f*, a spring f^1 is compressed, and when not in use the force of the spring is taken by the curved lugs e^1 e^1, which are cast on the casing of the valves. There is a second lever *k*, similar to the one just described, with its fulcrum and two springs. One is always in action, tending to keep the relief valve open; the tension of the other is taken by the lugs e^1 e^1. This lever is solely connected with the relief valve, which is in the same casting as the equilibrium valve; this valve, when the regulator handle is in the position shown in Figs. 17 and 20, allows the water which has been forced into the cylinders to be returned to the tank by the pipe attached to the regulator at *o*, Fig. 13. When the handle of the regulator is pulled towards the ends of the levers, the springs, no longer held out of action by the curved lugs, tend to pull down the levers; in so doing the equilibrium valve is opened, and remains so till the pressure on the piston *h* is greater than the pressure of the spring f^1, Fig. 20. When the piston *h* pushes up the lever and closes the valve, if the handle be now pulled over further from the fulcrum greater leverage is gained and the valve is again opened, the same process taking place as before; if the handle be now returned part of the distance the pressure on the relief valve overcomes the resistance of the spring *n*, and a reduction of pressure takes place, until the power of the spring *n* is in excess to the pressure on the relief valve. When the valve is closed during this retrograde movement the equilibrium valve remains closed, because, if the pressure on the piston *h* can close the valve *a* at a greater leverage, it will, of course, remain closed, while that leverage is being reduced. When the handle is pulled to the extreme end of the levers it will remain there till pushed back. —*Engineer.*

NEW BRICKMAKING MACHINE.

WE illustrate above a new brick machine, by R. W. Brownhill, of Birchills Foundry, Walsall, England. B is a strong cast iron frame, with moulding box S cast on it. Upon this frame the whole of the machine is fixed. C C are two square slide boxes to guide the pistons *e e*, which form two sides of the brick. The two pistons, which slide in the boxes C C, are fitted with strong friction rollers, which revolve and follow the two cams on the main shafts. The pulleys C *c*, and the chains and weights G G, are to keep the pistons with friction rollers to work close to the cams cast upon the main shafts during their irregular motion. The hammer to drive the clay into the mould S works on the slides A A, connected at the top by the cap *N*, falls during every revolution, and supplies and consolidates the clay through the hopper E into the moulding box S, and between the piston pallets *e e*. The hammer is operated upon by the helve Q T, which works upon a rocker R, which turns upon a gudgeon *g*, at the bottom end of the helve. T is fitted with a friction roller, to work upon the spiral U, which spiral is connected to the large spur wheel, and by this means the hammer is raised, and then dropped with the full force of its own weight. There is a radius rod which works upon the centers Z Y on the helve and standard, on the back side, which cannot be seen on the drawing, to guide the hammer. The large hopper W is for the purpose of holding a quantity of material for the screw, and is delivered into the hopper proper by the screw, which is driven by the cone pulleys *t t*, by a pair of bevel wheels, which are not seen upon the drawing, but are situated at the back of the hopper W. These cone pulleys are driven by the shaft and pinion working into the large wheel. The pair of bevel wheels X are worked from the same shaft, for the purpose of keeping the feeding screw clear. The pallets *e e* deliver the bricks upon the band P. This band is worked by a small band pulley situated on the other side of the machine from that shown on the drawing, and is worked by a pair of bevel wheels and shaft, actuated by the ratchet wheel S and pair of spur wheels, which are put in motion by the rod *r*, worked by the crank plate *q*. The pulley which drives the band P is lifted at the exact moment when each brick comes out of the mould, to take it off the pallets. This is accomplished by a lever, moved by a cam fixed on one of the large shafts at the back of the machine. The pallets *e e* are supplied with steam to make them hot to prevent the bricks from sticking to them. Clay is fed into the hopper W either by hand from the heap or from the grinding apparatus. The screw revolving at the bottom of this hopper carries an adjustable quantity of clay into the hopper proper E. Under this hopper the distance is regulated between the pallets for a regular quantity of feed, and in reality becomes the mould. Just at the moment the pistons are in this position the hammer falls, and forces the material into the mould. The motion of the cams causes one piston to retire while the other advances, and presses the brick. The retiring piston then entirely leaves the mould, and the advancing piston forces the brick out of the mould, to be taken away by the band before described, and thus completes one brick. The machine is adjustable in all its motions.

The machine works about twenty-two tons, and will, we are informed, make from 30,000 to 40,000 bricks per week at a cost of 1s. per thousand for attendance on the machine. It is stated that excellent bricks are turned out by this machine from raw clay entering unprepared. One has been worked regularly for the last nine months.—*Engineer.*



BROWNHILL'S BRICK MACHINE.

IMPROVEMENTS IN CARDING ENGINES.

A PATENT has been taken in Germany and France by MM. Klein, of Werdur-sur-Ruhr, for improvements in carding engines.

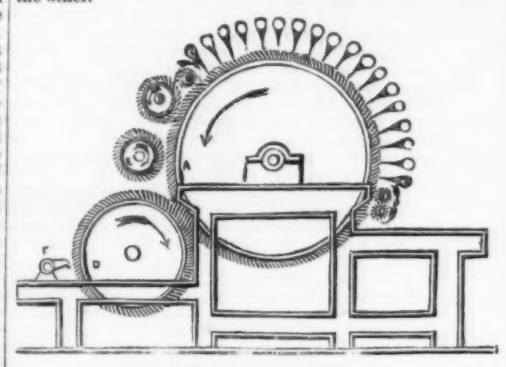
The improvements have been made principally with the view to the better carding of shoddy and other waste wool; and the inventor believes that he has achieved the object in view.

The inventor argues that in carding wool, and especially material having but little consistency, and even good wool which has suffered, however little, in the dyeing, in machines composed only of a series of cylinders, it is cut and shortened; such machines may indeed be called wool mills. The ends alone cannot produce such good yarn as the wool from which they were taken. This is precisely the consequence of defective carding.

In the new machine referred to, which is called *Carde à Peigneurs*, there is but one cylinder and a doffer, the other pieces being replaced by combs, the teeth of which are positive steel needles. The two qualities of a good card are, great elasticity of tooth, with very close setting; and these are possessed in a high degree by the toothed combs of the new engine, while the limit has already been reached with the ordinary cards. For example, a drum furnished with No. 28 cards will have a thousand teeth, while a comb with teeth of average thickness will contain fifteen hundred. Moreover, cards are obliged to be stuffed, because without that precaution their teeth are too weak to resist the material being dealt with, and care must be taken that the stuffing continues in proper condition and does not get hard, as in such case the cards will lose their elasticity and the fibers will be cut.

With toothed combs, on the contrary, all the desired elasticity may be obtained by employing teeth of the necessary length, and all stuffing is rendered unnecessary.

The accompanying figure represents the improved engine: A is the drum; B B' C and D, doffers and cylinders; all clothed with cards; F, comb; 1 and 1' feeding cylinders; 2 2 2 combs. The combs which replace the other parts of the old engine have the points of their needles directed obliquely towards the card of the drum, and approaching as nearly as possible, without absolutely touching it. The most open part of the wool delivered into the drum by the feeders enters the deepest between the cards, while the knots, the parts that are matted together, etc., are retained on the points of the teeth of the card, and, as the drum rotates, are carded, or rather combed, by the needles of the combs above, one after the other.



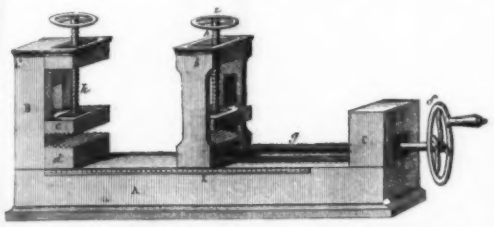
IMPROVED CARDING ENGINE.

In consequence of the great elasticity of the needle teeth, and their oblique direction in relation to the drum, the wool meets with little resistance, and that only momentarily, from each comb, and, as the teeth yield to the wool on the smallest pressure, the open fibers slip easily, and keep the combs clean during the working. Thus each comb opens up more and more the tangled or felted wool, but the knots are never caught, as they are by the cards in the ordinary engine. All the fibers combed by the points of the teeth are opened out in the direction of their length on the card of the drum, and have not to undergo any further strain, only being laid out evenly. Thus the fibers of the wool are more gently dealt with, and retain their original length better than when worked on the ordinary carding engine; and, both in the case of combed and carded wool, there is less waste.

The inventor, M. O. L. Klein, claims for his machine—the production of a finer and stronger yarn from inferior wool; fuller yield, because the cleaning during the operation is suppressed, and the layer of waste is consequently thinner; great economy in cards, because there is in the new engine only one worker and one cleaner; and the cards in the drum are relieved from the action of the breaker; great saving in motive-power; large economy in oil for lubrication, as the combs are fixed; saving in time and wages, as there is no cleaning, and, lastly, larger production, because the wool cannot, as in the case of the ordinary carding engine, slip between the worker and the drum when the engine is overfed.

DYNAMOMETER FOR MEASURING THE STRENGTH OF FABRICS.

FOR measuring the extensibility of cloth and the power necessary to tear the same, Mr. T. Hausner in *Dingler's Journal*, proposes the simple device, illustrated herewith. It consists of a fixed bed A, two clamps for holding



DYNAMOMETER FOR MEASURING THE STRENGTH OF FABRICS.

the cloth, and a straining screw. One clamp is stationary and is fixed to the support B. Its inner faces are corrugated, and the upper portion may be raised and lowered by the hand-wheel and screw *h*. The other similarly constructed clamp is movable and receives the horizontal screw *g*, which passes through the support C and is operated by the crank wheel *f*. The fabric cut to suitable length is secured to the clamps and submitted to regular extension by the screw, until torn asunder. The amount of stretch and point at which tearing occurs is noted on a scale graduated to millimeters, inscribed on the side of the bed. This machine is especially intended for detection of shoddy and other inferior material in the fabric.

WASHING AND WATER-BEATING.

M. VASSIVIERE, a French manufacturer, has, we are told, imagined an apparatus which performs both washing and beating by water all textile materials, and especially filaments in hanks, so as completely to clear them of all extraneous matters. The shocks are produced by water thrown with force against the material, which is supported by strong wood or other work, and the washing effected at the same time by the beating water running off, which carries the detached particles of matter away with it. Of course, as the inventor says, the force of the water may be increased at will, either by compression or fall, and produce all the effect of a blow from a solid body, with the great advantage of continuous action. It is possible, says the inventor, to give to any given surface a series of blows more or less numerous which, as it were, search throughout the material acted upon instead of acting only on the surface. The distinctive character of the invention, he adds, is the employment of the power of resistance belonging to liquids projected, to the beating of materials by the penetration and the continuity of the shock, with simultaneous carrying away of foreign particles by the water itself. It is not said whether the apparatus has actually been used or whether it is patented.

DEPOSITING COBALT UPON METALS.—M. R. Bœttger (*Chem. Centralblatt.*—By the use of two Bunsen elements a brilliant deposit of metallic cobalt was obtained upon brass or copper. The salt employed was the double chloride of ammonium and cobalt.

STEAM TREE-SAW.

MESSRS. A. RANSOME & Co., of Stanley Works, Chelsea, England, have recently patented their Steam Tree-Saw, as represented by the engraving.

It consists of a steam cylinder of small diameter, having a long stroke, attached to a light cast-iron bed-plate, upon which it is arranged to pivot on its centre, the pivoting motion being readily worked by a lever, as shown in the

PATENT TREE-FELLER.

engraving. The saw is fixed direct to the end of the piston-rod, which is caused to travel in a true line when at work by guides; and the range of the pivoting motion of the cylinder is such as to enable the saw to pass through the largest logs that are ordinarily to be met with, without moving the bed-plate. A strong wrought-iron strut is attached to the bed-plate, and this is furnished with two fangs, which are made to bite into the butt of the tree by a chain passed round it just below the saw-cut, and drawn taut by a powerful screw.

The machine is supplied with steam at a high pressure from a small portable boiler through a strong flexible steam pipe, and as this may be of considerable length, the boiler may remain in one place until the machine has cut down all the trees within a radius which is determined by the length of the steam pipe.

From the foregoing description it will be clearly seen that the only fixing the machine requires after it is laid down against the tree, is to draw it tight against the butt by the chain and screw above referred to; and as the whole apparatus, exclusive of the boiler, does not weigh more than about 3 cwt., it is readily carried about slung on poles between four men. The steam pipe does not require to be disconnected while the machine is being removed, and a special valve is attached by which it can be instantly started at any part of the stroke.

As the pressure of steam is high, the machine works with great rapidity, and under ordinary circumstances it will fell from four to six trees, averaging 30 inches in diameter, in an hour; and as it cuts nearly close to the ground, it saves a considerable amount of timber which is lost when felled with the axe.

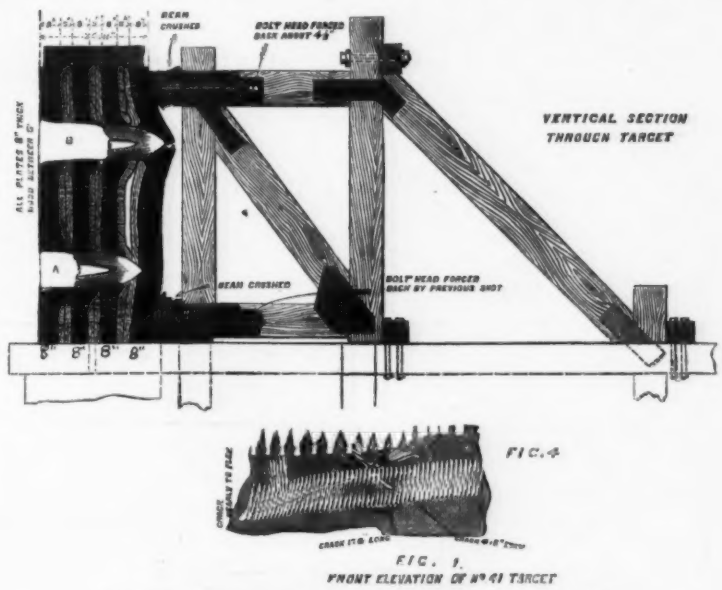
As the machine will work in any position, it will fell trees growing on slopes or in hedgerows, and by a simple apparatus, easily attached, it can be fixed so as to crosscut logs to length when lying on the ground.

THE EIGHTY-TON GUN.

THE trial of the 80 ton gun, with its enlarged chamber, took place at Shoeburyness, May 4. The following are the exact conditions under which the gun was fired: The chamber is enlarged to a diameter of 18 in., that of the bore being 16 in. This admitted of a charge being employed of 425 lbs. of powder, that previously used being 370 lbs., 1·5 in. cube in each case. The cartridge was not expanding, being brought up nearly to the diameter of the bore, and rammed home in its zinc cylinder to prevent friction and setting up. It was found that the zinc consumed very well, and prevented the likelihood of the cartridge jamming in the bore, as we had to report in the trial of the 38 ton chambered gun. The weight of the shot was 1,700 lbs., as before. We expressed our doubt as to the probable attainment of an additional 100 ft. a second initial velocity, and greater doubt as to such a difference existing between the striking velocities, owing to the fact that a shot proceeding at any very high velocity suffers great retardation from the disproportionate resistance of the air, owing to the difficulty experienced by the particles of air in closing in behind the shot, so that there exists in the wake of the projectile a vacuum retarding it, which vacuum becomes more perfect and powerful as the velocity increases. Such a velocity of 1,600 ft. a second would be considerably diminished even in such a distance as the range in question, namely, 120 yards. The actual initial velocity of 1,600 ft. was attained, with a striking velocity of 1,585 ft. This gives, as stored-up work, 29,615 foot tons, a penetrating figure of 589·17 per inch circumference, and a penetration into iron of 30·16 in. We quote these figures for the sake of comparison with the 100 ton gun, the projectile of which obtained a maximum velocity of 1,500 ft., with a stored-up work of 31,204 foot tons, and a penetrating figure per inch circumference of 584·27 foot tons, implying a penetration of 29·995 in.—calculating in each case by Major Noble's formula.

It will thus be seen that, in its chambered condition, the penetrative power of the 80 ton gun slightly exceeds that hitherto obtained by the 100 ton gun—the penetration of 30 in. being an advance of about 2 in. on that of the unchambered 80 ton gun. As we pointed out, these penetrations are only calculated for the case of complete perforation—that is to say, the 80 ton gun on this occasion ought to penetrate completely a target with about 30 in. of iron; but this is by no means the same thing as penetrating 30 in. into a target 32 in. thick. The firing, as before, took place at the structure known as No. 41 target, consisting of four thicknesses of 8 in. plates and intermediate layers of 5 in. of teak. The shot struck a spot about 6 ft. from the proper left and 7 ft. from the bottom of the target. The hole in the front plate was rather larger than should have been; either from the shot not striking quite steadily and truly, or from the setting up of the metal of the shot during penetration. The point was visible through large cracks in the back of the target, in some places open to a width of 2½ in. There was about 5 in. of iron still in advance of the point, but this was fissured and opened in a star crack, shown in Fig. 4. The back plate was bulged or bent back nearly 14 in.—as shown in Figs. 2 and 3—and the horizontal beam behind the top of the target crushed and split from end to end. The bolts passing through this beam now protruded at the back to an extent reaching from the targets proper left to right of ½ in., 1½ in., 4 in., 4½ in., 2 in., and ½ in. consecutively. There was no appearance, however, of any of the bolts having been broken. The target, then, had stood well.

As to the shot, it was found to be considerably more broken up than on the last occasion. On the whole, the opinion is that the quality was not quite so good as that of the one fired in the previous round. It is thought by most that the enlargement of the hole in the front plate is due to the setting up and fracture of the shot on impact. Nevertheless, it is to be borne in mind that we are considering the case of the hardest blow that has ever yet been struck against armor. It is difficult to say precisely how much the shot might break at such a velocity. No one, probably, looking at the sharp clean point, as it appears through the cracks at the back, would say that was a bad one. The shot has, in fact, done as nearly as possible what was expected of it. It does appear, however, to strengthen the remembrance of the fact that the base of our shot is the weaker part—a conclusion that would favor the re-introduction of steel projectiles, which are said to hold together much more completely than chilled shot. The gun stood the firing well, and the zinc cylinder of the cartridge was completely consumed in the bore. The result being, on the whole, satisfactory, and closely agreeing with what had been anticipated, no second round was fired.—*Engineer.*


BEAM CRUSHED
BOLT HEAD FORCED BACK ABOUT 4½"
VERTICAL SECTION THROUGH TARGET
ALL PLATES 8" THICK WITH SUNKEN EDGES
BEAM CRUSHED
BOLT HEAD FORCED BACK BY PREVIOUS SHOT
8" 8" 8" 8"
FIG. 4
FIG. 1.
FRONT ELEVATION OF No 41 TARGET

NEW TRIALS OF THE 80-TON GUN.

DESTRUCTION OF A TURKISH MAN-OF-WAR.

ON Sunday, May 6th, a Turkish ironclad with two turrets paid a visit to Braila, and threw some fifteen 9 inch shells right over the town to the railway station, just as the Grand Duke Nicholas arrived by train from Galatz. The vessel did not remain long, and on the following Friday, the 11th ult., she returned about 3 P.M., and dropped anchor, with the object apparently of shelling the town. She several times shifted her position slightly, in order to bring her guns to bear more conveniently. A Russian battery at once opened fire on her with bronzed rifled howitzers of about 6 in. caliber, the range being 5,000 yards. A second battery, armed with 25 pounder siege guns, also opened on the Turkish ship, and the cannonade lasted for about 45 minutes. The Russians fired in all about twenty rounds; the result of each shot was carefully watched for by our correspondent on shore, from the point, and 50 ft. to 60 ft. above the level of the river. Suddenly, a small puff of white smoke or steam rose from the ironclad, followed by huge flames, which ascended to a height of some 20 feet. These were carried away by the wind at a slight angle, and were succeeded by a cloud of dark smoke or steam rising high into the air, and surrounded by black objects. A dull report was heard, and when the smoke cleared away the ironclad was gone. Nothing was to be seen of her but the mizen-mast standing far out of the water and still flying the Turkish flag, which, curiously enough, the Turkish boats, pulling to the rescue of the drowning sailors, did not attempt to secure. These boats came from a second Turkish ironclad lying at the time a little further up the stream. Whether they succeeded in rescuing any of the crew is not known. But the cook of the ship was subsequently picked up by the Russians, who also carried off the Turkish flag as a trophy. The man was much hurt, but he was quite able to give the explanation of the occurrence which has been so much wanted. It seems that the commander of the Lutfi Djelil had gone ashore at Matchin, about four or five miles further up the Danube, and had given instructions to his second in command to get the ship into position, but not to open fire until he returned on board; and, as a fact, the Turkish ship did not reply by a single gun to the Russians. His object in going to Matchin was to arrange with four other gun vessels for a concerted attack on Braila, which, as we know, never came off.

Numerous explanations of the cause of the sinking of the Lutfi Djelil have been given, and a great deal has been said about vertical fire and unarmored decks. According to the survivor, however, all of these theories are wide of the mark. A shell entered the side or base of the funnel, and exploding in the up-take the boilers at once followed suit. Further than this the cook knows nothing until he was picked up; but it is probable that a hole was blown in the bottom of the ship sufficiently large to admit water enough to sink her at once. Our correspondent states definitely that there is no reason to think the magazine exploded. There was no sufficient uprush of flame and smoke, and the noise made was not great. He describes the flame as being like that of a burning tar barrel, accompanied by black smoke. All this is quite consistent with the explosion of the boilers. It was not possible safely to make any examination on the spot after the ship went down, even if such examination could have had any results, for a body of Circassians, posted among some willows on the river bank, were very busy with their rifles. The crew consisted of 182 men, 20 officers, and 3 pilots, all of whom were Turks. The vessel, which is not the most powerful Turkish war ship on the river, had only three weeks previously passed quite close to the Roumanian shore as she proceeded up the main stream. She then caused quite a sensation in Braila by her size and hostile appearance. She did not, however, return by the main stream, but by the old arm of the Danube, entering a little below Hirsova. Two of the Russian officers who laid the howitzers have been decorated.

The Lutfi Djelil—not Latif Gelil, as the words are erroneously written in this country—was 204 ft. long, 43 ft. 3 in. beam, drew 9 ft. forward and aft, and was 1,751 tons burden. Her armor was 4½ in. thick, her nominal horse power 200, and she carried in the forward turret two 9 in. Armstrong guns, and in the after turret two 7 in. Armstrong guns, while a 40 pounder Armstrong was mounted for fire right ahead in a small battery at the bow

It will be seen that vertical fire had little or nothing to do with the destruction of the ship, the range being 5,000 yards and the batteries not far above the water's edge.—*Engineer.*

TORPEDOES.

LIEUTENANT-COLONEL MARTIN, Box Grove, Guildford, late commanding 4th (King's Own) Royals, writes to *The Times* on the subject of an "International Anti-Torpedo Association," which, he states, he is about to set on foot. He says: "When explosive bullets and chain shot were invented, and actually used in war, nations unanimously agreed to discontinue their use, and prohibited their manufacture; yet explosive bullets and chain shot, it must be admitted, are harmless as compared with torpedoes. Poisoning is prohibited in war. Why not prohibit torpedoes, which are actually more subtle and deadly than poison, there being no antidote to or escape from them? For instance, were I allowed to fire from a mortar gutta-percha bags filled with strychnine and charged with a 'burster' and time-fuse to cause the bag to burst and scatter its diabolical contents over some obstinate city or fort which would not capitulate, this visitation would be far more merciful in its way towards the people of that city or fort than torpedoes would be against crews of ships, because strychnine could be seen, and avoided by flight, whereas, on the other hand, torpedoes secretly moored, or even fish torpedoes, insure complete, sudden, unexpected, and unavoidable destruction. Several clever artisans have already been killed by merely pumping compressed air into the tails of unloaded fish torpedoes. Had these torpedoes been loaded with gun-cotton for service on board ship, and even if one of them exploded from careless handling during action while compressed air was being applied to start it, or if by chance a shot or shell struck the ship at the time of starting a fish torpedo on its death track, the fearful consequences may be easily imagined. As a proof that governments appreciate the danger they incur by the use of torpedoes, I may here state it is well known that after the Austro-Italian wars all the picked-up torpedoes proved to be 'dummies.' It is our bounden duty to keep pace with other countries, but every one will admit that the sooner the International Anti-Torpedo Association has accomplished its task the better for humanity."

LESSONS IN MECHANICAL DRAWING.

By Professor C. W. MacCord.

Second Series.—No. X.

On the Screw Propeller.

Few, if any, more important or interesting subjects than the screw propeller present themselves to the notice of the draughtsman; and the determination of the various curves essential to its accurate representation furnish exercises of considerable nicety, and sometimes of no little complexity. Still, if taken in progressive order, they are not such as ought to frighten any one who has followed us thus far; and we propose, therefore, to enter now upon their consideration, beginning with the most elementary.

Probably the most simple form of the propeller is that technically called the "true screw," properly enough, too, the acting surface being portions of right helicoids, or, in other words, identical with the warped surface of the common square-threaded screw, which was described in Lesson XXII. of the preceding series.

And probably the mode of representing a propeller of this form will be more readily understood, if at first we disregard the thickness of the metal and imagine the vanes or blades to be mere surfaces. The abstract form of the surface, as generated by a right line, perpendicular to the axis of the screw, and advancing uniformly along that axis while also revolving uniformly around it, was shown in Fig. 220, Lesson XXV. of the First Series. Perhaps it may aid some of our readers to look at the matter in another way, thus: Let us imagine a winding staircase in a circular shaft, the steps radiating from rim of the blade in *I*, to the corresponding points *a* and *b* on the outer helix in *II*; if *c*, *d*, be similarly projected from *I* to the inner helix in *II*, *a c* and *b d* in the latter view should be perpendicular to *C D*.

But if the length of the hub in *II* be given, we must first draw *c a* and *d b* perpendicular to *C D*, and then project *a* and *b* to the corresponding points in the outer circle in *I*; after which the radial lines *a c*, *b d*, are drawn as the outlines of the blade, determining the points *c*, *d*, in the end view, which should correspond to those similarly lettered in the side view, and completing the sector *a b d c*.

In the top view, *III*, the hub appears as a rectangle, the central point of which is the projection of the vertical element *e f* of the blade; and *c f d*, *a e b*, are portions of helices, although the curvature is so slight that they seem nearly straight. But it will be seen that the blade in this view appears precisely like that part of the dotted extension in *II*, in the region of the point *g*; so that the lines mentioned are not straight, although they are frequently drawn so. This error may not be of any great moment in a working drawing, for the reason that from the manner of making the mould the lines will in spite of it be helices when the screw is cast. But with that we have nothing to do, as it is presumed that our readers wish to draw correctly, and it is our object to show them how.

Now, it will be noted that the lines *a c*, *b d*, are foreshortened in the side view; they are actually as long as *e f*, which will be clear from a glance at *I*. As the propeller turns round, then, the points *a* and *b* will come respectively to *k* and *l*; that is, the screw will just sweep round within a cylinder formed by the revolution of the outline *k l* around the axis *C D*. We point this out particularly, because we have known the impression to be obtained, from attention to the side view only, that the propeller would turn within a circular box whose meridian outline is the curve *a e b* in that view.

Next, we observe that this elementary blade has two sharp corners at *a* and *b*; this is practically objectionable, as the corners are liable to catch against and be broken by obstructions; but this liability may be greatly lessened, with very little loss of effective surface, by rounding these corners off.

In doing this, it is common to proceed in one of two ways: we either assume the appearance of the blade in the end view, by drawing there a curve, usually for simplicity's sake the arc of a circle, tangent to the side and the rim of the blade; or we round off the corners of the imaginary cylindrical box within which the screw is to revolve, and fashion the blade to suit that condition.

The principles involved in the construction of the curves, in those views in which they are not assumed, are substantially the same in either case, the one operation being the converse of the other; but it may be of interest, and certainly will be of benefit, if we illustrate both methods, which we will do.

In Fig. 67, then, we assume that the blade is of such form that in the end view the corner shall appear rounded off by the arc whose center is *c*. This arc is tangent to the radial outline at the point *a*, which is projected to *a'* and *a''* in the side and top views respectively. The assumed arc is also tangent at *b* to the outer circumference or rim of the propeller; and this rim is as before represented in the other views by the helical curves, which must be first drawn, and then *b* is projected to *b'* and *b''* upon those curves. We see, then, recollecting that two lines which are tangent in fact will appear tangent in any projection, that in the views *II* and *III* the new curves, representing the rounded corner of the blade, will extend from *a'* to *b'*, and from *a''* to *b''*, at which points they will be tangent to the original elementary outlines.

In order to find an intermediate point, let us imagine the propeller to be put in the lathe and turned down to a smaller diameter, so that its new rim shall be represented in the end view by the circle *d e*. The actual line on the surface of the blade will of course be a helix, lying on the cylinder whose radius is *C e*, the pitch being the same as that of the others already drawn; and it cuts the assumed arc *a b* in *f*. We have, then, to project *e* to *e'* in the side view, construct the helix *e' d'*, and project *f* to *f''* on this helix. The position of the corresponding point in the top view might be determined in a similar manner, that is, by constructing the projection of this new helix in that view, and letting fall a perpendicular from *f'* upon it. This, however, is unnecessary, since having two projections of the point we can find the third more readily, thus: The center line *P R*, in *II*, corresponds to *M N* in *III*, and *f''* must be perpendicularly under *f*, and *f''* *g*, its distance from *m n* must be equal to *f' g*, the distance of *f'* from *P R*. By repeating this process, as many points in the curves may be found as are considered necessary; as in all other cases of this nature, the number needed will vary with the conditions, and it is well to keep in mind what has been remarked, that the fairness and regularity of the curve is a test of the accuracy of the work. In views *I* and *III*,

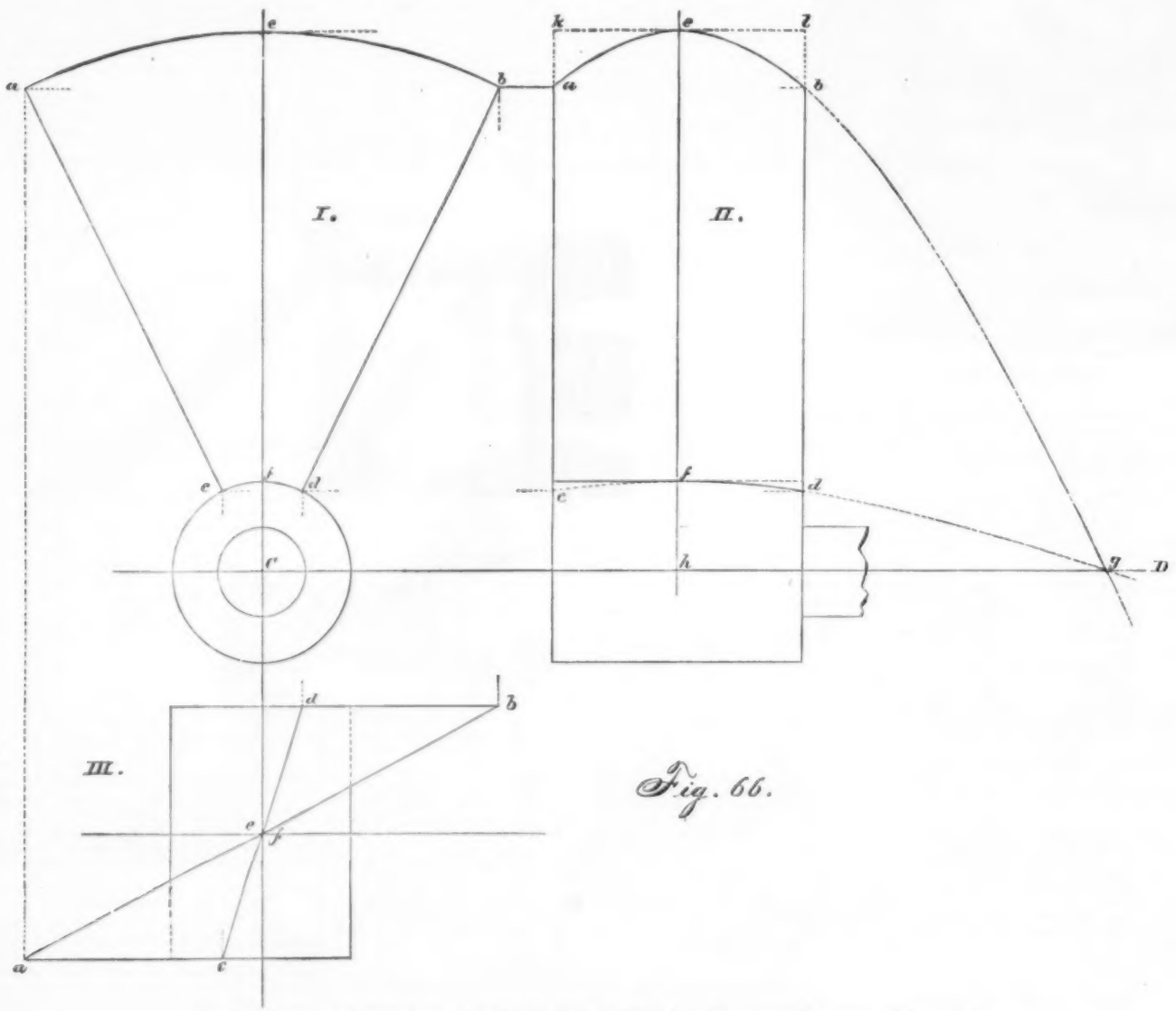


Fig. 66.

LESSONS IN MECHANICAL DRAWING. Second Series. No. 10.

a small central column; if the steps be made very low and narrow, their edges will come very close together; and we may suppose this diminution to continue until the steps disappear, becoming mere lines of a continuous surface, still remaining horizontal and radial as at first. This surface will be our helicoid, out of which we may cut a portion bounded by any outline we choose for the blade of our screw propeller. Let us suppose the diameter of the well or shaft of the staircase to be the same as that of the proposed screw, and the diameter of the central column to be that of the hub, which may be, as it often is, cylindrical. Then the simplest form of blade will be obtained if two radial lines be selected as the remaining boundaries; and such a one, with its hub, is shown in Fig. 66. In the end view, *I*, the cylindrical hub is represented by a circle, whose radius is *C f*, and the blade, being bounded by radial sides, appears as a part of the sector of the larger circle, whose radius is *C e*. Now, if we regard *C e* as the vertical element of the helicoid, it will be seen in the side view, *II*, as *h e* perpendicular to *C D*.

The point *e* describes a helix lying on a cylinder whose diameter is that of the propeller, and the point *f* another lying on the surface of the hub, the pitch being the same. In the figure, *h g* is one-fourth the pitch, whence the reader will find no difficulty in constructing the helical curves *a e b g*, *c f d g*.

Now, if we assume the arc *a e b* in the end view, the length of the hub is found by projecting the points *a*, *b*, on the

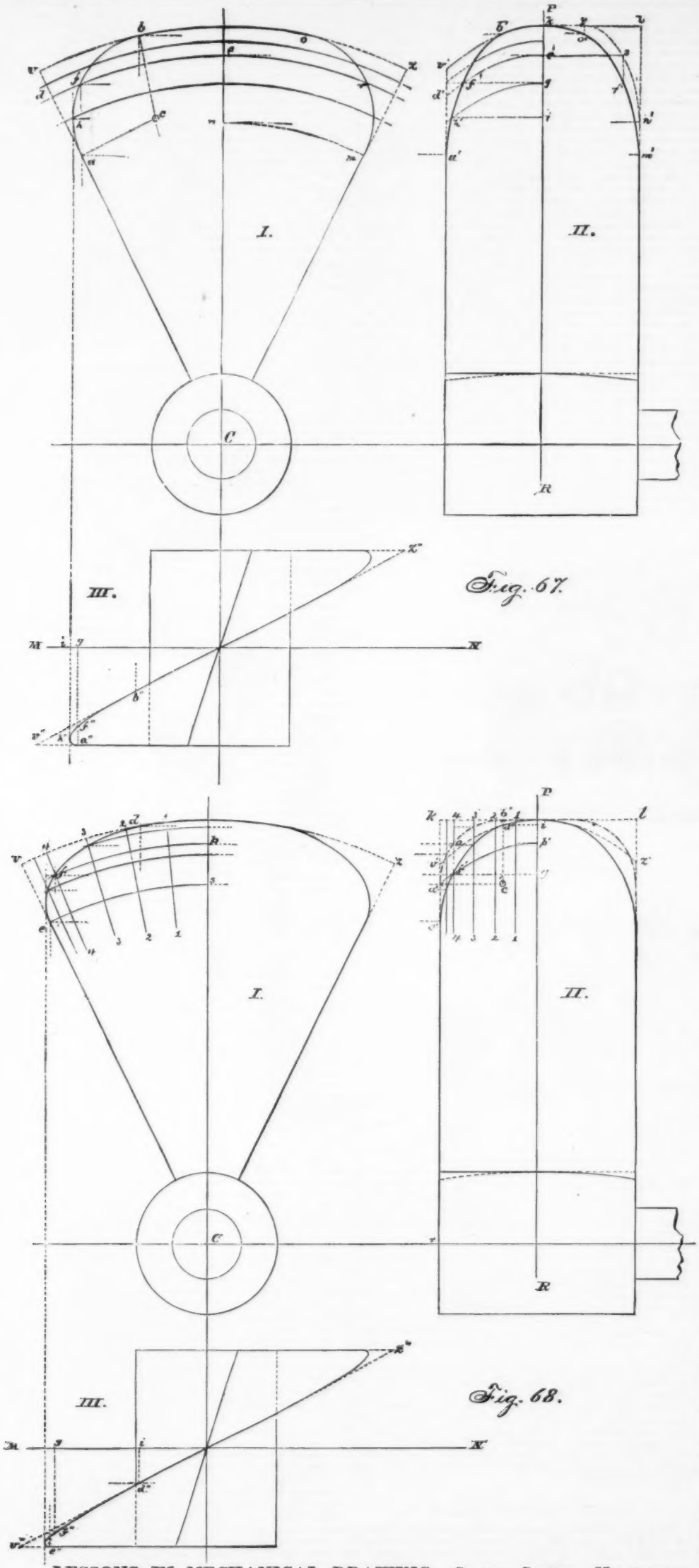


Fig. 67.

Fig. 68.

fectly symmetrical. The point o', being on the outer helix, will in its revolution come to q, perpendicularly over o', and on the line $k\,l$. The point m' will go to n', found by revolving m in I to its highest point n, which is projected to n', perpendicularly over m'. So, also, the point r', describing a circle whose plane is perpendicular to the axis, will go to s, found by revolving r in the end view about U to its highest position e, which is then projected to the side view, where it appears perpendicularly over r'.

The required curve then is tangent to $k\,l$ at q, to $l\,m'$ at n', and passes through s; and any desirable number of other points may be introduced by repeating the above operation. And we repeat that, when this method of rounding off the corners of the blade is adopted, it is absolutely necessary to determine this curve, in order that in planning the surroundings of the propeller we may be sure not only that the screw can turn round but that reasonable and known clearance may be allowed for the purpose of avoiding danger of breakage by the catching of obstructions between the blades and any adjacent part.

These processes being fully understood, the student should be able readily to follow the explanation of the converse of the last problem, for that is substantially what is involved in determining the form of the blade, when the outline of the box, within which the screw may be imagined to turn, is assumed.

In Fig. 68 we have the same elementary blade as in the two preceding figures, the arc $v\,z$ corresponding to the helical curves, $v'\,z'$, $v''\,z''$, in the other views, and $k\,l$ being the meridian line of the cylindrical box within which this blade would revolve.

We now round off the corner of this box, as shown by the circular arc $a'\,b'$, whose center is c, tangent to $k\,l$ at b', and to the side $r\,v'$ at a', and we are required to find the effect of this upon the form of the blade.

The point d', perpendicularly under b', and lying on the helix $v'\,z'$, is the one which in revolving will come to b'. This may be at once projected to d, on the circle $v\,z$ in the end view; but the intersection of the circle and the projecting line being at a very acute angle, the determination may be more accurately made by the aid of the top view, thus: The center line $m\,n$ in III corresponding as before to $P\,R$ in II, draw a line parallel to $M\,N$, at a distance, $d''\,i$, from it, equal to $d'\,i$, the distance of d' from $P\,R$. This parallel cuts $v''\,z''$ in d'', which is then projected to d.

Now, projecting a' to s in I, and revolving it about C, we find e, which, being projected back to $r\,v'$, gives e' in II, and of course e'' in III is perpendicularly under e. We have thus the limiting points of the required curves, at which they will be tangent to the elementary outlines of the blade.

It will now be apparent that, as already stated, the problem of finding intermediate points may be solved by inverting the process described in connection with Fig. 67. For instance, o, on $a'\,b'$, is the highest position to be occupied by some point in the blade as it turns; and since in turning this point describes a circle whose plane is perpendicular to the axis, it must in the side view be found somewhere in the vertical line through o. It must also lie on the helix which passes through it, which helix in the end view is represented by the circle, found by projecting o to p in I, and revolving it about C.

If, then, we construct this helix in the side view, it cuts the vertical line through o in f', a point in the required curve. This may then be projected to f, on the circle through p in the end view, after which f'' is located in the top view, being perpendicularly under f, and $f''\,g$ being equal to $f'\,g$. Or, should the intersection in the first part of this operation be too acute, we may adopt the expedient before mentioned, by constructing the new helix in the top view, and determining f from f'', as d was located by the aid of d''. And, as usual, we complete the curves by simply repeating the process until we have found points enough to develop their forms with the required degree of precision.

We have given this explanation because it is necessary not only to a clear comprehension of the relation between this problem and the preceding one, but to a similarly clear understanding of a method of expediting matters and saving time, which we will now describe. In the construction of the helix, as shown in Fig. 120 (Lesson XX, First Series), it is most convenient to divide the circle in the end view, and the pitch in the side view, into the same number of equal parts. Now, in Fig. 68, instead of taking the points, as o, etc., at random, in finding the corresponding points in the required curves, it is better to proceed systematically, thus: Beginning at the vertical center line in the end view, set off the equidistant points, 1, 2, 3, 4, measuring aliquot parts of the circumference of the outer circle; then the radial lines, 1–1, 2–2, etc., will represent the generatrix of the helicoid in equidistant successive positions, in this view. In the side view, beginning at the vertical center line $P\,R$, set off on $k\,l$ the points 1, 2, etc., marking equal subdivisions of the pitch corresponding to those of the circumference, already set out; then the vertical lines 1–1, 2–2, etc., will represent the generatrix in the same positions in this view also. These lines are essential to the drawing of the different helices made use of in the processes above described; but having these lines, we may in this last problem omit the helices altogether, at least in determining the curves $e'\,f'\,b'$ in the side view, if we select as the starting points the intersections of the assumed arc $a'\,o\,b'$ with the vertical lines 1–1, 2–2, etc. To illustrate: The point o lies on the line 4–4 in the side view; it is, then, the position occupied after revolution by a point whose actual location on the blade is on the generatrix represented by 4–4 in both views. And to find that location, we have only to set off on 4–4 in the end view, a distance $C\,f$ equal to the distance of o from the axis; which is most readily done by projecting o to p by means of the T-square, then setting the compasses to the radius $C\,p$, we mark the point f on 4–4 at once, and project it back to f' in the side view, without actually drawing either the arc $p\,f$ or the helix $p'\,f'$ at all. We also gain another practical advantage in respect to the nature of the intersections, the radii being cut normally in the end view, by the circles, and the vertical lines 1–1, 2–2, etc., being also cut at right angles by the horizontal ones used in the counter-projection to the side view. But the reader will observe that the principle of the first explained is still involved; what we have done is simply this: We have so chosen our starting point that the point sought for shall coincide with one of the points employed in constructing the auxiliary helix. This being understood, it need hardly be pointed out that the same labor-saving expedient may be used with equal advantage in the converse operation. Thus, had the curve $e\,f\,d$ in the end view been assumed, we would have had only to project f, its intersection with the radius 4–4, to f' on the corresponding vertical line 4–4 in the side view, which would give a point in the curve $e'\,d'$; and marking off $C\,p = C\,f$, we would find o by projecting p to the same vertical line, thus locating a point in the curve $a'\,b'$.

All which being much more direct and expeditious than the method explained in connection with Fig. 67, the reader is recommended by all means to use this process in practice.

It was remarked above that, when the propeller is cast, the outer rim, and the intersection of the blade with the cylindrical hub, will be helices whether they be shown as such on the drawing or not. The principle of the mode of making the mould, which renders this result inevitable, may be thus described: Suppose a rigid horizontal straight-edge to be firmly secured at one end to a cylinderical socket, free to turn and also to slide upon a fixed vertical rod, surrounded by any plastic material. If we simply swing the straight-edge round, at a fixed height, without any vertical motion, the effect evidently will be to sweep or level off the irregularities, and form a plane surface. But if while turning the straight-edge be moved up or down, we shall as evidently sweep up a surface which is not plane, but depends on the relation between the two motions; and if both be uniform, it will be the helicoidal surface. The lower or acting edge of the horizontal arm, it will be readily seen, corresponds in its different positions to the edges of the steps of the winding staircase in the illustration made use of at the outset. And this relation may be and practically is attained in this way: The rod is placed in the axis of a large cylinder, or part of one (technically called a guiding iron, probably because it is made of wood), a portion being cut away so as to leave a true helical edge, upon which the outer end of the horizontal sweep rests. When the latter is rotated, then, it is also compelled to rise exactly in accordance with the pitch of the helical guide curve, and consequently sweeps up a surface literally answering to the definition of the right helicoid, as at first given.

NEW ELECTRO-MAGNETIC ENGINES.

By MARTIN EGGER, of Mariaschein, Austria.

Two oscillating beams, A and B, Fig. 1, are employed, from each of which two armatures, $a\ b$ or $a'\ b'$, are suspended, so that in all four armatures are suspended above four pairs of magnets, C D E F. The arrangement is such that the armatures are successively attracted, each by its own respective electro-magnet. The armatures are so suspended that during their reciprocating up-and-down motion they can swing on horizontal axes $c\ c'\ d\ d'$ attached to the beams A B. Below each of the said axes a small square frame, e, Fig. 2, is suspended so loosely as to allow of the end of the beam going a little further down, after the armature rests on the magnet, but carrying up the armature along with it when the respective end of the beam goes upward. The frame e is provided with a set-screw, to enable the distance of the armature from the beam to be adjusted, which has to be done in such a manner that the armature will rest on the magnet when the respective end of the beam has nearly reached its lowest position. Each of the two beams is connected at one end with one of the two cranks $n\ n'$ on a driving-shaft. As the oscillating center of each beam is situated between two armatures, these armatures balance each other, and the weight of the rod G or G' connecting each beam end with the crank n or n' may be counterbalanced by a weight, O or O', attached to the other end of the beam.

In order to insure the vertical movement of the armatures, each of them is provided at the bottom with a guide-piece, $p\ q$, sliding in a suitable guide arranged between the magnets.

The motion of the engine takes place as follows: First, one of the four pairs of magnets—C, for instance—attracts one of the four armatures, a, and thus causes one of the two beams, A, to move downward with one end, and thus pushes downward one of the two cranks, n, which was situated to the left, and therefore rotates the crank-shaft through ninety degrees, arrangement being made so that each electro-magnet exerts its power while the crank on which it indirectly acts is situated between the dead-points. As the two cranks are arranged at an angle of ninety degrees to each other, the second crank n' will now be situated to the left horizontally, and therefore between the dead-points. Then a second pair of magnets, D, attracts the armature a' suspended at the reverse end of the second beam B', which, through its connecting-rod G', turns the second crank n' through another ninety degrees. The first crank n will now be situated horizontally to the right, and the third pair of electro-magnets E, attracting the third armature b suspended at the other end of the first beam A, this end goes downward, thus causing the other end to rise and draw up the first crank n through ninety degrees. The second crank n' will now be situated horizontally to the right, and when the fourth armature C' is now attracted by the fourth pair of magnets F, the other end of the second beam D, and therefore the second crank n' connected to it, will be drawn up through ninety degrees. The first crank n will now be situated horizontally to the left, and the whole proceedings will be repeated, as above explained.

In this way the alternate attraction of the four armatures will cause an uninterrupted rotation of the crank-shaft, on which a flywheel, S, may be arranged.

The commutator may also be arranged on the crank shaft. It may be constructed of contact-springs, gliding over a surface alternately conducting and non-conducting, as seen in Fig. 3, or an arrangement may be used by which contact devices may be alternately dipped into mercury, serving as a conductor, as shown in Fig. 4. In the first case the commutator is constructed as follows: On a cylinder, K, of non-conducting material, such as bone, wood, or vulcanite, four metallic plates, three of which, $y^1\ y^2\ y^3$, are visible in Fig. 3, are arranged in a row, but alternately around the circumference of the cylinder, so that each occupies rather more than ninety degrees of the circumference. These metal plates are in metallic contact with each other as well as with a metal disk, r, fixed to one end of the cylinder, and a contact-spring, s, rests on the said metal disk, and is connected with the positive pole of the circuit. Four contact-springs, $t\ t'\ t''\ t'''$, rest on the circumference of the cylinder, and are each connected with one end of the wire of one of the four pairs of magnets, the other ends of the said wires being connected with the negative pole of the circuit. The entire arrangement is made so that each contact-spring alternately touches a metal plate on the cylinder, and is therefore brought into the circuit, and remains in contact until the next contact-spring is brought into the circuit, and for a moment later, so that the entire circuit is never entirely broken at any moment, but is merely passed over from one electro-magnet to the other. The non-conducting parts of the cylinder are marked with the letters $z\ z''\ z'''\ z^{iv}$.

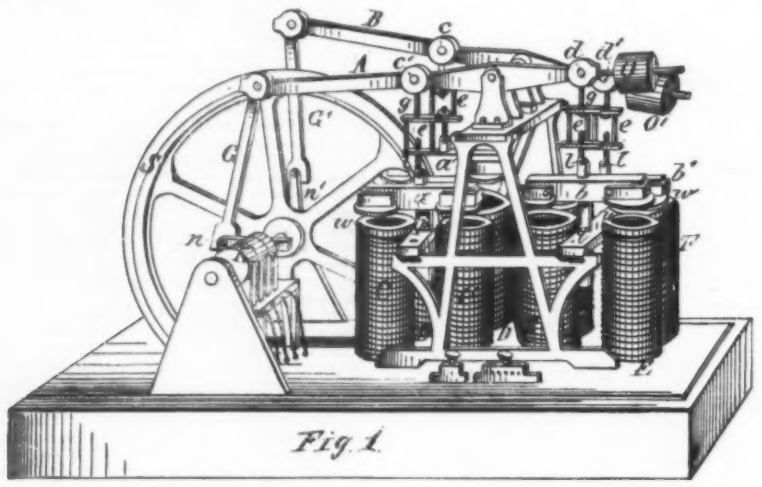


Fig. 1.

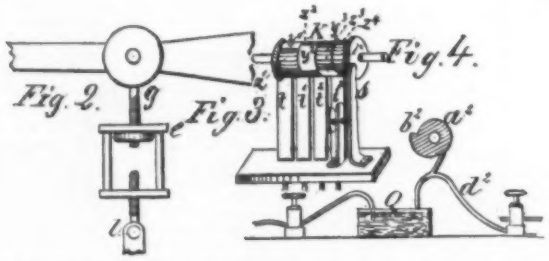


Fig. 2. Fig. 3. Fig. 4.

NEW ELECTRO-MAGNETIC ENGINE.

When mercury is to be used as a conducting material, the commutator may be constructed as follows: Instead of the above-mentioned cylinder, a set of four cams, b^2, Fig. 4, non-conducting material, may be employed, which are so arranged that alternately one of the four contact-springs, d^2, is dipped, by the pressure of its respective cam, into a vessel, Q, containing mercury, and with which the positive pole of the circuitis always in connection. In this case, also, the arrangement is such that each contact-spring, and therefore the magnet connected with it, does not come out of the circuit until another magnet has been brought into the circuit by its respective contact-spring.

In order to receive any shock that might be occasioned by the armatures dropping on the pole ends of the magnets, rings, $w\ w$, of india rubber or leather may be arranged thereon.

Without departing from the substance of this invention, the electro-magnets may be provided with hollow iron cylinders, placed over the coils.

It is evident that, instead of two oscillating beams, with four armatures and magnets, three beams, with six armatures and magnets, or four beams, with eight armatures and magnets, may be employed. When using three oscillating beams, the cranks may be arranged at an angle of sixty degrees to each other, or with four beams at an angle of forty-five degrees.

THE ELECTRIC CANDLE.

THE value of electricity as a source of artificial light has always been recognized, and its utilization has frequently been attempted. The great obstacle, however, which has hitherto prevented the practical attainment of this object is the difficulty of subdividing an electric current, and producing a number of lights from one main source. This subdivision of the current, as it flows from the generator, has several times been attempted, and in some cases—experimentally, at least—it has been attended with success. The fine carbon points were, however, quickly consumed when burnt in contact with oxygen, and thin platinum wires melted as soon as they began to give a perfect light, and, so far as we are aware, no system of subdivision of electricity has come into practical operation.

About the first who attempted to solve the problem was M Lodyghin, of St. Petersburg, who, some few years since, used a vacuum, burning the carbon out of contact with the oxygen of the atmosphere. The details of his apparatus, however, were imperfectly worked out, and failure resulted.

M. Kosloff then took up M. Lodyghin's idea, and in time succeeded in producing an efficient means of subdividing the electric light. By forming the holders for the carbon points of a special metal, and producing the light in a vacuum lamp, excellent results were produced.

M. Kosloff's apparatus was exhibited in London in May, 1874, and some very successful trials were made with it, and reported upon by us at the time. It does not, however, appear that this invention went beyond the phase of experiment, at least in England, although it was an invention of great promise. Hence, wherever electricity has been utilized, as in lighthouses and for signalling or other purposes, the constant shortening of the carbon points by combustion has to be compensated for, and followed up by clockwork, so that the necessary distance between the points is preserved as nearly uniform as possible.

It has remained for another Russian man of science—M. Paul Jablochkoff, who was formerly in the Russian military service—to demonstrate in practice the feasibility of subdividing the electric current. He has worked out his results in the form of an electric candle, which governs the production of the electric light, and supersedes the ordinary clockwork arrangement. By it he has, moreover, demonstrated the possibility of obtaining several lights from a single source of electricity.

The first practical trial of this system was made two weeks ago at the Magasins du Louvre, and the experiments were attended with perfect success. The Marengo Hall was the apartment lighted, and six electric candles were sufficient to shed around a very bright light, which was softened by being transmitted through oval glass globes. Some idea of the comparative value of gas and the electric light under notice may be formed when we state that the Marengo Hall is ordinarily illuminated by means of one hundred argand gas burners of the largest size. The cause of the wide difference between this and other electric lights lies in the fact that electricity plays, so to speak, only a secondary part in producing the light. The light is principally the result of the combustion of the refracting material, which occupies in the electric candle the same position as does wax or tallow in ordinary candles.

The electric candle, as originally designed by M. Jablochkoff, consisted of what may be termed a double wick and a surrounding material. The wick consisted of two carbon points, about four inches long, embedded parallel to each other in an insulating substance, by which also they were separated from each other. This material, which was consumed as well as the double wick, was composed of several ingredients, forming a combination known only to the inventor. Each of the carbon points terminated at the bottom in a small metal tube into which the conducting wires were led. With these candles a series of experiments was some time since carried out by a War Office Committee of Royal Engineers at Chatham. It was then demonstrated as one result that the system gave fifty per cent. greater power of light than had ever before been obtained from any electric light. The next development of the electric candle by M. Jablochkoff was to denude it of its outer casing, leaving merely the double wick with a strip of the insulating compound between the carbon points, which terminated at the bottom in metallic tubes, as before. It was with the electric candle in this form that the hall at the Magasins du Louvre was illuminated, as previously stated. In either case only one electrical machine is needed to produce a number of lights. The positive and negative wires are led from the machine, and branch wires are simply conducted from them at the necessary points to the candles. In this way M. Jablochkoff succeeded in getting as many as eight candles to burn at the same time in the circuit of a single machine of the ordinary kind, with alternating currents.

Arrangements are being made in England to light up one of the East and West India Dock Company's docks in London upon M. Jablochkoff's system, so that the loading and unloading of ships may be carried on by night as well as by day when desirable. Experiments were to have been primarily made in order to test the system, but since the exhibition of the electric candle at the Louvre, M. Jablochkoff has still further improved his system, so that the experiments have been postponed for the completion of the details of the improvement. In the new form of candle the inventor dispenses with the carbon points which constituted the wick, and uses only the outer surrounding material answering to the tallow of an ordinary candle. We have already seen that this compound—to which M. Jablochkoff has given the name of "kaolin," which substance enters largely into its composition—consumes at the same rate as the carbon points. From this material alone M. Jablochkoff now produces results superior in many respects to those which he previously obtained. One point of superiority consists in the fact that he is now enabled to produce as many as fifty constant and uniform lights from a single machine of the ordinary kind, as was recently stated in a paper brought before the Academy of Sciences, in Paris, by M. Dumas. In short, M. Jablochkoff appears to have satisfactorily solved the question of dividing up the electric light by a method capable of practical application, of insuring perfect steadiness in the light so divided, and of distributing throughout a building lights of varying degrees of intensity. The results point to a very wide application of the system, which appears to possess special advantages for the lighting up of theatres and other large buildings.—*London Times.*

HEAT.

IN a recent lecture at the Royal Institution, Prof. Tyndall, with the aid of the thermo-electric pile and the galvanometer, illustrated the consumption of heat in the conversion of crystals into a solution, salt consuming more heat in the process than sugar, and saltpeter more than common salt. This illustration was continued with alcohol and ether, showing the consumption of heat in the vaporization of liquid. Water, placed under the air pump in company with sulphuric acid, which consumed the vapor of the water, could be frozen in that way. A simple experiment of this kind was shown: A glass vessel containing water was connected by a

tube with another glass vessel exhausted of air, and covered with a cloth wetted with salt and water; the vapor from the water passing into the empty vessel was condensed, and during the course of the lecture the water, thus deprived of its heat, became frozen. With reference to the heat produced and liberated in molecular processes, Prof. Tyndall stated that 8 lbs. of oxygen and 1 lb. of hydrogen, combining to form 9 lbs. of water, produced an amount of heat which, expressed in mechanical force, would be sufficient to lift 47,000,000 pounds a foot above the earth's surface—in other words, its effect was equal to 47,000,000 foot-pounds. The first effect of the combination was to produce aqueous vapor, and in the passage of that vapor to water the amount of heat set free would be equal to the raising of 6,720,000 lbs. a foot above the earth's surface. In the passage of the 9 lbs. of water to ice, the heat liberated would be equal to 993,654 foot-pounds. In treating of the subject of liquefying gases, Prof. Tyndall produced snow from carbonic acid gas, and froze quick-silver in the process of melting the snow. In connection with this experiment, he referred to the deposition of snow upon the Alps by the rarefaction of the air blown from the plains of Lombardy; in the process of rarefaction work was done, in the doing of which heat was expended, and by the consequent reduction of temperature the moisture held in the air became condensed, and fell as snow.

A HOME-MADE TELESCOPIC EQUATORIAL STAND.

By T. D. SIMONTON.

THE next thing for the amateur, after becoming possessed of a telescope,* is to secure a proper mounting for it. Of course a small instrument can be held in the hand simply, and something can be seen in that way. But any one who has seen a star dance in the field of vision, or has had his bloodless arms drop, perforce, before getting even so much as a sight of the object sought, will want something better. And we believe there are thousands of ingenious young men in our country, who are able to make or to buy a modest instrument, who come short of a most admirable pleasure and instruction, because they either do not know the capabilities of a small glass when properly mounted, or have no idea that such a mounting is within their reach, as it probably is not, in the ordinary way.

But Proctor in Great Britain and Draper in America have

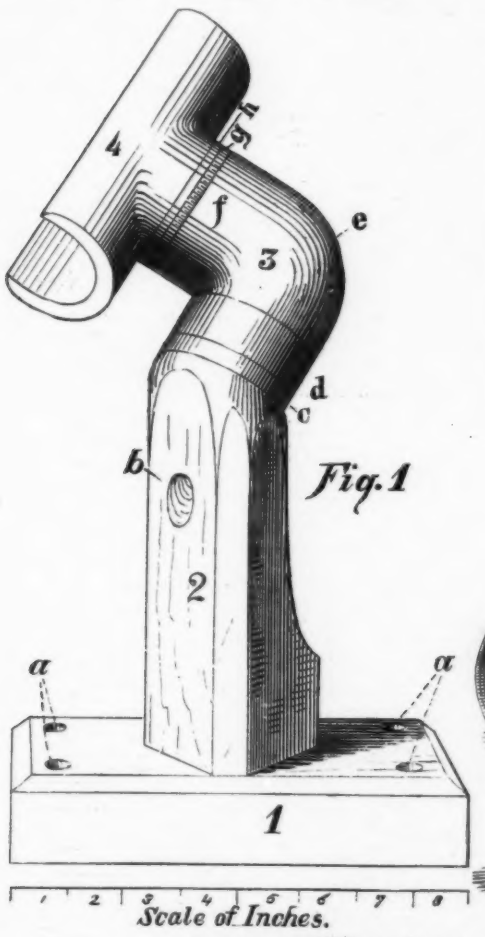


Fig. 1

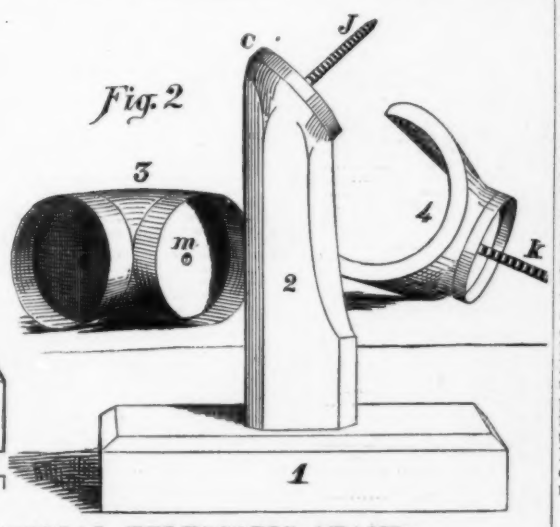


Fig. 2

A HOME-MADE EQUATORIAL TELESCOPIC STAND.

recently had occasion to refer to the value of observations to be made by good glasses of but an inch or two aperture. And, indeed, almost all general work connected with the motions and the positions of the heavenly bodies, such as the places of the sun and moon in right ascension and declination, their distance from each other or from any star, the observation of eclipses and of occultations, can be done with an instrument of little power, if very close measurements are not required. And no such valuable adjunct to maps of the heavens, such as are to be found in many homes, is to be conceived as a telescope that may not cost more than $10 or $12, if need be. But to be of greatest value it must be adequately mounted, that is, if possible, *equatorially* mounted.

And this brings us to the object of this article, which is to describe and illustrate with figures an inexpensive yet efficient little equatorial mounting we have devised, and which we think, were its merits to be known, many would like to possess. It can be made by any cabinet-maker, and at a cost of but two or three dollars. Indeed, almost any person of ordinary skill at working in wood should be able to make one for himself, and thus secure, at nominal cost, what could not be obtained of the instrument-maker for less than several times the cost of a modest telescope, such as we have referred to.

*See article on Construction of Telescopes in Supplement No. 1 of SCIENTIFIC AMERICAN.

This mounting will be seen in Fig. 1, below. It consists of the pieces 1, 2, 3 and 4; a base block, an upright piece, an angle or elbow, and a grooved rest for the telescope. The base block (1) is intended to be screwed to the top of a post, or to the outer post of a window sill. The upright or post (2) rests upon this base perpendicularly, and is fastened to it by a strong screw (not seen in the figure), with its head let into the under side of the base block. This allows motion, so as to facilitate in adjusting the post to the true meridian, after the base block is made fast. When nice adjustment is secured, the base block can be removed from its fastenings and the strong screw made fast so as to hold the post firmly to place, when the whole affair can be returned, or at any time placed in correct adjustment, by simply screwing it down to the place where it was first adjusted. If this be a window-sill, looking south, we will say, all that will be necessary to adjust it to a window looking west will be to loosen the strong screw and rotate the post 90 degrees to the left, when the screw can be again tightened; and the same in principle for any other direction or outlook.

But we now come to the angle or elbow (3), all-important in this arrangement. It is absolutely necessary that the motions we secure where this is connected with pieces 2 and 4 be at right angles to each other. We make sure of this by taking two turned wooden boxes, of some 2½ inches diameter, and gluing them (the bottoms of them) to the adjoining sides of a perfectly square piece of wood. We thus obtain the elbow (3) (best seen in Fig. 2); and as the boxes and lids are alike *turned*, the circles obtained are not only true but parallel with the bottoms of the boxes, and consequently, if the boxes are glued to a square piece of wood, their planes will be at right angles to each other. This is what we want; and by simply gluing the lids of these boxes in proper position to pieces 2 and 4, and placing the whole thing together—each lid to its box—we obtain the two motions of the hour circle and the declination circle, belonging to an equatorial mounting. These circles can be graduated as any other circles, and distances and angles on the heavens thus be measured with facility. The closer the graduation and the greater the nicety of the whole mechanism, the finer the measurements that can be made, of course. Good hard maple tooth-powder boxes, with clean smooth rims and lids, are most suitable for the purpose we here speak of; and the joints should be well rubbed with a very soft lead pencil to secure smoothness of motion when all is placed together for use.

Fig. 2 will show the arrangement more in detail. Of course it is known that the hour circle on the top of the upright (2) must be in the plane of the equator, consequently the screw *j* adapted to the hole *m* of piece 3 must be parallel with the axis of the earth, or, in other words, point to the true pole of the heavens. The letter *b* (Fig. 1) shows when the head of this screw is let into the post. It must have a rotating motion in this hole, the thread fitting so tightly in piece 3 as to hold firmly. By tightening or loosening the screw, the proper amount of friction may be secured to hold the telescope firmly, yet allow motion when it is desired. The same of the screw *k*, adapted to the hole *l*, in piece 3. The head of this screw is let into the bottom of the groove *i*, Fig 1, where the telescope is placed, of course, when all is completed. The telescope can be firmly tied or strapped in place, and any simple device be used to secure its being truly parallel with the declination circle, in case it be an instrument with joints.

The letters *a a*, Fig. 1, show the screw holes for the base. The letters *c d f h*, the boxes as used, with their lids, and the letter *g* the graduated circle for declination. [By mistake the lid, instead of the *bottom*, of one of the boxes used to make the specimen from which our illustrations are taken was glued to the squre block *e*. This should not have been, as thereby the right angle position of the two circles was jeopardized.] We have spoken of the *square* block to which the boxes are glued. The block must be square to get the connections true, in a simple manner, but of course, after this has been effected, the whole thing can be rounded, as in the figures, for the sake of appearances.

The simplicity of the whole affair and its slight cost arises from the fact that it is easy to get a block of wood square, and that turned boxes (costing a dime each) are necessarily square in position when built upon this. Besides, the rims of the boxes have an excellent catch in their lids, and so run true when rotated, and make good smooth circles.

We cannot here go into the niceties of adjustment belonging to the equatorial telescope. These will have to be sought in books. It may be sufficient to say here that when the slope of the top of the post is made as many degrees and minutes from the horizontal as the place of the observer is degrees and minutes from the north pole, and when this slope faces directly north, neither to the right nor the left, then the declination circle being adjusted to the latitude of any star, that star can be followed from horizon to horizon and kept constantly in field by the mere rotation of the hour circle. By carefully graduating this circle, dividing it into three hundred and sixty equal parts (something the amateur should learn to do), distances in right ascension between bodies can be measured, and by the same process with the other circle their declination be measured. This is the beginning of true astronomical research, and at least puts one in position to appreciate the wonderful results that have been obtained by the greatest workers and greatest instruments of our day. It may do more. It may inspire some of us to a career in this direction that will be one of continued progress. There is a delight in feeling that we can make and arrange for *ourselves* an instrument with which we can begin to trace out the great paths of the heavenly bodies. And it is with the hope of helping some that can afford nothing more complete at present that we present them with the design of something they can afford, and that will be of great service to them—the Amateur Equatorial Telescope Mounting.

[THE ACADEMY.]

SCIENCE NOTES.

On the Poisonous Effects Usually Attributed to Salts of Copper.—In a communication to the Academy of Sciences (*Comptes Rendus*, April 9, 1877) Galippe points out that, although the various compounds of copper give rise to severe vomiting when administered in large doses, the same compounds may be taken for long periods of time in smaller doses, progressively increased, without the occurrence of any unpleasant systems. Burq and Ducom fed dogs every day during two months on food which had been cooked, and allowed to cool, in copper vessels previously exposed to the action of vinegar and salt, without producing any poisonous effects. Galippe himself, for more than a month, lived on food cooked with or without vinegar in untinned copper saucepans, whose contents were often allowed to remain for twenty-four hours in contact with the metal before they were put on the table. The various dishes thus prepared, though often coated at their edges with the greenish matter commonly termed verdigris, were partaken of, both by himself and by other members of his family, without giving rise to any dangerous or even disagreeable symptoms.

Zinc a Normal Constituent of the Body.—Lechartier and Bellamy have found that zinc is constantly present, in appreciable quantities, in the liver of the human subject and of many lower animals, such as the calf, ox, and dog (*Comptes Rendus*, April 9, 1877). They also demonstrated its presence in hens' eggs, in wheat, barley, maize, and haricot beans. These facts have an obvious bearing on certain medico-legal questions.

Animal Heat.—At a meeting of the Société de Biologie on April 14, 1877, M. Claude Bernard communicated the results of some fresh investigations on this subject (*Gazette Méd. de Paris*, April 28, 1877). The first part of his communication referred to the temperature of the blood in different parts of the circulatory apparatus. By introducing long and slender thermo-electric probes into the larger arteries and veins, he succeeded in ascertaining that while the temperature of the blood in the aorta and its more important branches is uniform, that of the venous blood varies considerably in different regions of the inferior cava and its principal tributaries. At the junction of the extremities and the neck with the trunk of the body, the venous blood is colder than that in the great arteries; in the right heart it is decidedly hotter. If we determine its temperature at successive points in the inferior cava, we find that at the junction of the iliac veins this is lower than the arterial temperature; on a level with the entrance of the renal veins, the two are about equal; on a level with the hepatic veins, the temperature of the venous exceeds that of the arterial blood by some tenths of a degree. It maintains this superiority even after it has become mixed in the right heart with the colder blood returned through the superior cava. Accordingly, though the venous blood of peripheral parts is colder than that in the arteries, it acquires sufficient heat during its passage through the abdominal cavity, not merely to equalize the difference; but actually to give it a permanent advantage. It must not, of course, be inferred from these results that the abdominal viscera are, in any special sense, the source of animal heat. They are simply protected by their situation from the effects of radiation and evaporation. If a limb be carefully swathed in cotton-wool, so as to guard against any loss of heat from its surface, the blood returning from it will be found hotter than that conveyed to it, even when the muscles are kept in a state of absolute repose. Heat is generated in all the tissues: in the muscles, the nerves, the nerve-centers, the glands. The rise of temperature which may always be detected in a muscle when thrown into a state of contraction is invariably preceded by a slight but distinct depression. Precisely the same phenomenon is exhibited by a gland when its secretory nerve is stimulated. For instance, if the sub-maxillary gland be excited through the chorda tympani nerve, a thermo-electric needle having previously been implanted in its substance, a momentary fall of temperature may always be noticed to precede the rise which coincides with the occurrence of secretion. In the last part of his paper, M. Bernard insists on his old doctrine of the difference between thermic and vaso-motor nerves, and promises further investigations on the subject.

Physiological Action of Glycerin.—A very elaborate research on this subject is published by M. Catillon in the *Archives de Physiologie* (Janvier-Février, 1877). He finds that glycerin, when administered in considerable doses, has a very decided power of lessening the decomposition both of the fatty and of the azotized constituents of the body. Animals increase in weight under its influence, and the daily amount of urea excreted is lessened. The diminished excretion of urea must be due to diminished production, not to obstructed elimination; for no excess of urea is found to accumulate in the blood. In moderate doses, glycerin acts as a mild laxative, and improves both the appetite and the digestive powers. Whatever the dose administered, none can ever be detected, either in the intestinal excreta or in the perspiration. All that enters the stomach is absorbed; but only a certain quantity is capable of being decomposed in the system. When this limit is overstepped, glycerin makes its appearance in the urine; in the human subject, it begins to be eliminated by the kidneys when the dose taken rises above twenty grammes. Elimination begins in less than an hour after it is taken, and is completed in from four to five hours. The urine never contains any trace either of albumen or of sugar. When a very large quantity of glycerin is swallowed in one dose (15 grammes per kilo. of body weight), death usually takes place, the *post-mortem* lesions being similar to those after acute poisoning by alcohol. The same quantity of glycerin, however, may be administered in divided doses without ill effect; this is to be accounted for, in all likelihood, by the rapidity with which any excess of the compound is eliminated through the kidneys.

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The * indicates that the Article is illustrated by Engravings.

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